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A SATELLITE RADAR ALTIMETRY DATA ANALYSIS COMPUTER PROGRAM FOR --ETC(U)

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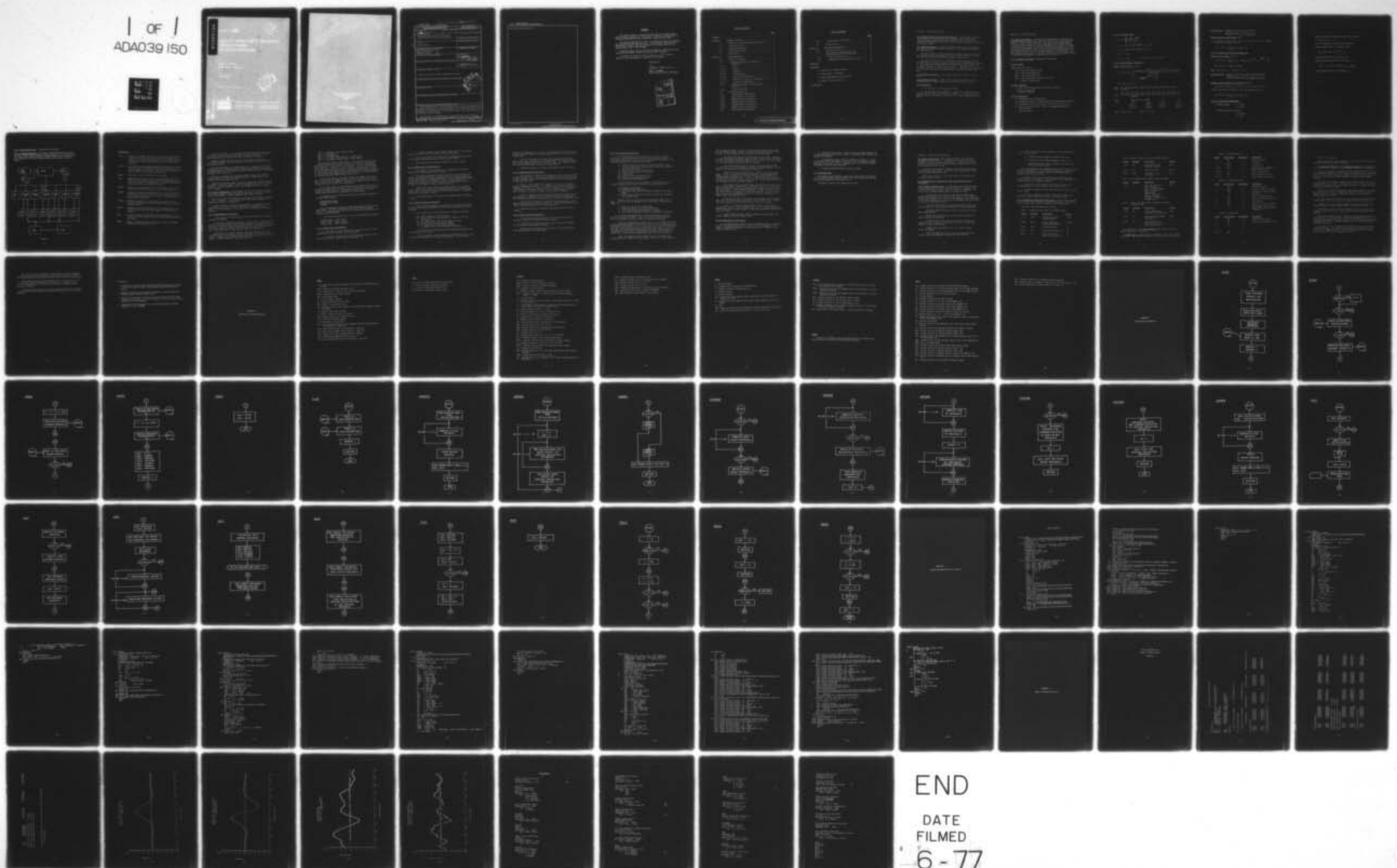

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A SATELLITE RADAR ALTIMETRY DATA ANALYSIS COMPUTER PROGRAM FOR GEODETIC APPLICATIONS

by

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APRIL 1977

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The information given in this maintenance manual contains a description of a computer program used to study the feasibility of the Wiener-Kolmogoroff filter as applied to satellite radar altimetry data at sea. Useful radar signal data is imbedded in noise which has to be filtered in order to recover deflections of the vertical and geoid heights.

Also included, is the definition of program variables, macro-flowcharts, an Extended Fortran IV listing, sample input/output, and some of the program → next page

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operational characteristics.

FOREWORD

This manual presents a computer program used at the Naval Surface Weapons Center, Dahlgren, for the purpose of studying the feasibility of the Wiener-Kolmogoroff filter as applied to radar altimetry data.

The task was performed as an aid to a preliminary study in simulating and interpreting radar altimetry data. This study was conducted by the Astronautics Division under the guidance of Mr. Samuel Smith III, Dr. Charles Cohen, and Dr. Bernd Zondek.

Financial support for the task was provided by an ARPA grant for Research and Development studies of satellite radar altimetry.

Mr. Robert N. Learn, Mr. Frank V. Werme, Jr., and Mr. Samuel L. Smith, III are acknowledged as reviewers of this manual.

Released by:

RALPH A. NIEMANN
Head, Warfare Analysis Department

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SECTION 1. General Description

1.1 Purpose of the Program Maintenance Manual. The objective for writing this Program Maintenance Manual for "A Satellite Radar Altimetry Data Analysis Computer Program for Geodetic Applications" is to provide the maintenance programmer personnel with the information necessary to effectively maintain the system.

1.2 System Application. During the program design stage, this program was called the "Radar Data Analysis Program." It has the code name RADAP for identification.

Basically, RADAP is used to develop and evaluate analysis techniques for applying the Wiener-Kolmogoroff Filter to recover deflections of the vertical and geoid heights from radar altimetry data at sea.

In order to study the filter feasibility, RADAP processes synthetic data generated by a computer program, SARAS, which is described in Reference 1. This controlled synthetic data, when processed by RADAP, permits one to readily evaluate the qualities of the filter. These results can then be used to optimize the filter characteristics. Reference 3 gives an account of the filter evaluation for various types of synthetic altimetry input data.

1.3 Equipment Environment. The computer program is coded for the CDC 6700.

1.4 Program Environment. Coding of the computer program is in the Extended Fortran IV language which operates with the Scope 3.3 system.

1.5 Conventions.

a. The code name for this program is RADAP.

b. This program, RADAP, requires an input file as generated by the computer program SARAS; see Reference 1. However, real radar altimetry data can also be processed by this program if it has the appropriate input format.

SECTION 2. System Description

2.1 General Description. The purpose of this program is to analyze the simulated radar altimeter data produced by the Satellite Radar Altimetry Simulation (SARAS) computer program. This analysis is accomplished by applying a Wiener-Kolmogoroff filter (developed in NWL TR-2626; "Accuracy of Deflection of the Vertical Derived from Satellite Altimetry" by Charles J. Cohen and Bernd Zondek, for the TASC autocorrelation function) to the noisy simulated data and evaluating the accuracy of the geoid heights and the deflections of the vertical obtained against the "true" values. If this program performs well, it will form the heart of an operational system to analyze data produced by the GEOS-C and other satellites.

2.1.1 Program Description. Mathematical Formulation

2.1.1.1 Input.

SARAS Output Tape (File)

x(i) - Data Point Position (km)

Y(i) - True Geoid Height (m)

YN(i) - Noisy Geoid Height (m)

D(i) - True Deflection of Vertical (arc sec)

N - Number of Data Points

2.1.1.2 Controls.

a. Select Geoid Height and/or Deflection of Vertical

b. Filter Fit Span (±L)
(number of points)

2.1.1.3 Constants.

β - Reciprocal decay distance (km^{-1})

σ_δ - Standard deviation of single point distance measurement (meters)

$\sigma_{N'}$ - Standard deviation of deflection of the vertical (arc sec)

Δs - Filter fit spacing (km) - must be an integral multiple (ℓ) of data spacing

ℓ - $\Delta s/\Delta x$ (integer)

2.1.1.4 Precomputations.

(1) $$R = \left| \left(\frac{16\sigma_N^{\,2}}{\sigma_\delta^{\,2} \Delta s \ \beta^3} \right)^{\frac{1}{3}} \right|$$

(2) $$\rho_1 = (1/2) \left[2\sqrt{1 - R + R^2} + (R - 2) \right]^{\frac{1}{2}}$$

(3) $$\rho_2 = (1/2) \left[2\sqrt{1 - R + R^2} - (R - 2) \right]^{\frac{1}{2}}$$

(4) $$s_j = j\Delta s$$

(5) $$r_j = \beta |s_j| \qquad j = -L, -L+1, \ldots, -1, 0, 1, \ldots, L-1, L$$

2.1.1.5 Geoid Heights Computation.

Compute Filter Weights, $W_N(x_i)$

(6) $$F(r_j) = \frac{R}{6} \left[\frac{\rho_1(\mathrm{Sin}\ \rho_1 r_j + \sqrt{3}\ \mathrm{Cos}\ \rho_1 r_j) + \rho_2(\sqrt{3}\ \mathrm{Sin}\ \rho_1 r_j - \mathrm{Cos}\ \rho_1 r_j)}{\sqrt{1 - R + R^2}} \right.$$
$$\left. \cdot e^{-\rho_2 r_j} + \frac{1}{\sqrt{1 + R}}\ e^{-\sqrt{1+R}\ r_j} \right]$$

(7) $$W_N(s_j) = \beta\ F(r_j)$$

Note: The following example illustrates the spacing relationship between x_i and s_j

Data: x_{i-5} x_{i-4} x_{i-3} x_{i-2} x_{i-1} x_i x_{i+1} x_{i+2} x_{i+3} x_{i+4} x_{i+5} x_{i+6}

ΔX

Fit (ℓ=3): Δs

s=-1	s=0	s=1	s=2
$W(x_{i-3})$	$W(x_i)$	$W(x_{i+3})$	$W(x_{i+6})$
$W(s_j=-1)$	$W(s_j=0)$	$W(s_j=1)$	$W(s_j=2)$

Plot: $W_N(s)$ vs x_i , $-L\Delta s \le s \le +L\Delta s$

Title for Plot: Weighting Function for Geoid Height
Run No. ___________, Date _________
Data/Noise Type __________/__________

Compute Smoothed Geoid Heights, $\hat{N}(x_i)$

For each x_i from $i = -(N - 1)/2 + \ell L$ to $i = (N - 1)/2 - \ell L$ compute the estimated geoid height, $\hat{N}$, by:

$$(8) \qquad \hat{N}(x_i) = \Delta s \sum_{j=-L}^{L} W_N(s_j)\, YN(i + j\ell)$$

2.1.1.6 Deflection of Vertical Computation.

Compute Filter Weights, $W_{N'}(x_i)$

$$(9) \qquad F'(r_j) = \frac{R}{6}\left[(\text{Cos}\, \rho_1 r_j - \sqrt{3}\,\text{Sin}\, \rho_1 r_j)\, e^{-\rho_2 r_j} - e^{-\sqrt{1+R}\, r_j}\right]$$

$$(10) \qquad W_{N'}(s_j) = \text{sgn}(s_j)\, \beta^2 F'(r_j)$$

Plot: $W_{N'}(s_j)$ vs x_i , $-L\Delta s \le s_j \le L\Delta s$

Title for Plots: Weighting Function for Deflection of Vertical
Run No. ____________, Date __________________
Data/Noise Type ____________/______________

Compute Smoothed Deflection of Vertical, $\hat{N}'(x_i)$

For each x_i from $i = -(N - 1)/2 + \ell L$ to $i = (N - 1)/2 - \ell L$ compute the estimated deflection of the vertical, $\hat{N}'(x_i)$, by:

$$(11) \qquad \hat{N}'(x_i) = \Delta s \sum_{j=-L}^{L} W_{N'}(s_j)\, YN(i + j\ell)$$

2.1.1.7 Statistical Comparisons.

If Geoid Heights:
$$s_i = \hat{N}(x_i)$$
$$s_i' = Y(i)$$

If Deflection of the Vertical:
$$s_i = \hat{N}'(x_i)$$
$$s_i' = D(i)$$

Compute residuals of "Estimated" and "True" values by

$$(12) \quad \Delta s_i = s_i - s_i'$$

Print the Maximum Value of Residual, $|\mathrm{Max}\ \Delta s_i|$

Compute Average Value of Residuals, $\overline{\Delta s}$, by

$$(13) \quad \overline{\Delta s} = 1/(N - 2\ell L) \sum_{i=1}^{N-2\ell L} \Delta s_i$$

Print the Average Value of Residual, $\overline{\Delta s}$

Compute Standard Deviation of Residuals, σ_S, by

$$(14) \quad \sigma_S = (1/(N - 2\ell L) \sum_{i=1}^{N-2\ell L} (\Delta s_i - \overline{\Delta s})^2)^{\frac{1}{2}}$$

Print Standard Deviation of Residuals, σ_S

2.1.2 Program Description. Definitions and Structure

2.1.2.1 General Structure. The computer program RADAP consists of an executive routine called RADAP and seven subroutines. These subroutines are called TLIST, GHCMPTS, CMPSGH, STATCØM, DVCMPS, PLØT, and SCALE. A chart showing the interrelationships between the routines is given in Figure 1.

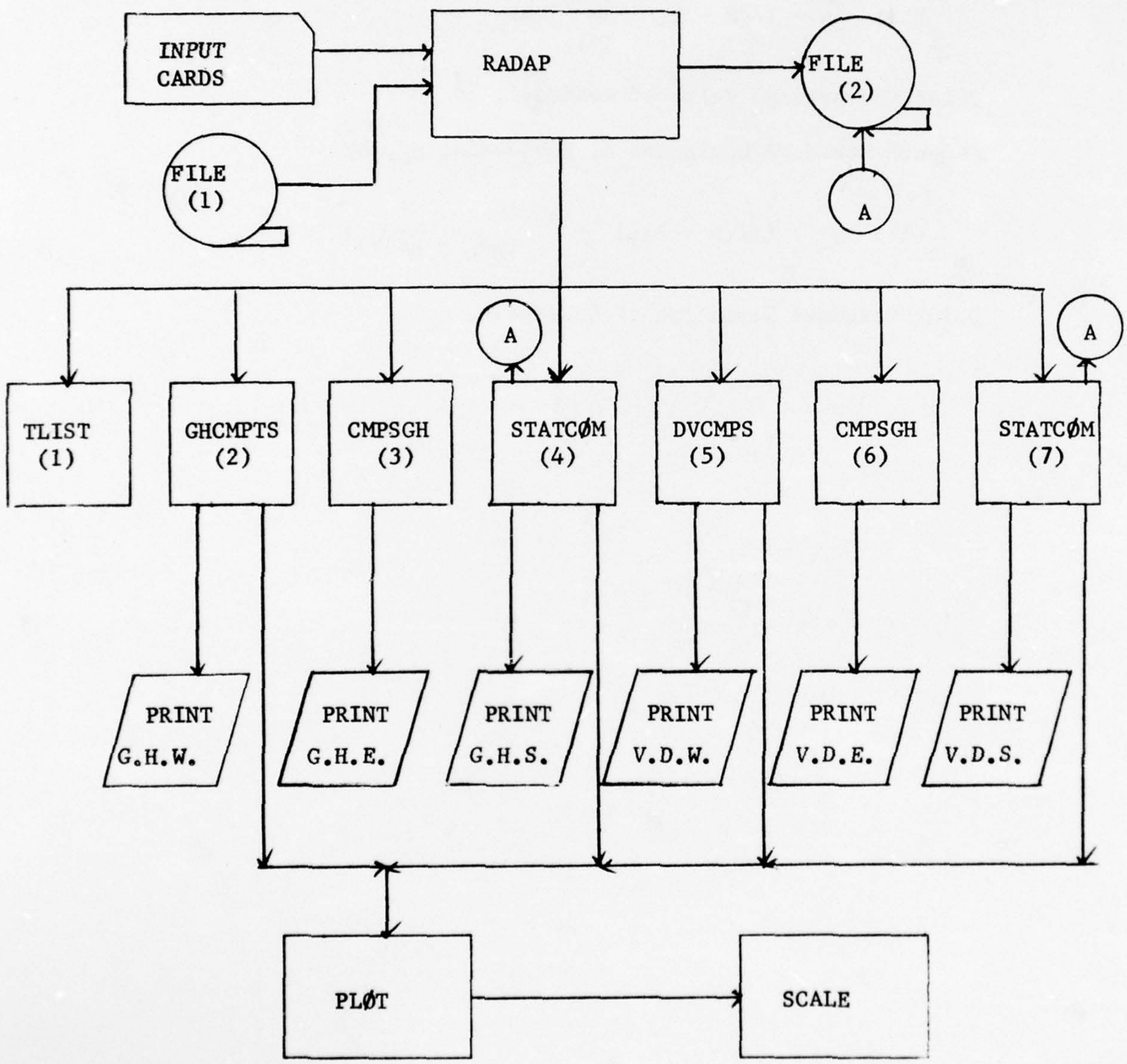


Figure 1.

Definitions:

File 1 - Input file to RADAP containing a header record and two data records. The first data record contains the along track distances and the noisy geoid heights. The second data record contains the smooth geoid heights and the true vertical deflections.

File 2 - The output file from RADAP containing four records. The first two are header records and the last two records are data records. Records three and four contain the geoid height and the vertical deflection residuals, respectively.

RADAP - Executive or control routine for the program.

TLIST - Reads the data records of File 1 into the appropriate array locations. These data records contain the Along Track Distance Array, the Noisy Geoid Height Array, the Smooth Geoid Heights Array, and the Vertical Deflection Array.

GHCMPTS - Computes the geoid height filter weights, $W_N(s_j)$, for all data points and plots these weights vs along track distance x_i.

CMPSGH - Computes the smoothed Geoid Height, $\hat{N}(x_i)$, or the smoothed Deflection of the Vertical, $\hat{N}'(x_i)$, arrays dependent upon which set of filter weights, $W_N(x_i)$ or $W_{N'}(x_i)$, are residing in the filter weight array (WN).

STATCOM - Residual statistics for Geoid Height or Deflection of the Vertical are computed in terms of maximum average and standard deviation values.

DVCMPS - Computes the vertical deflection filter weights $W_{N'}(s_j)$, for all data points and plots these weights vs along track distances x_i.

PLOT - A control routine for all RADAP plotting requirements. It controls the titling, labeling of axes, and plotting of points for each graph.

SCALE - Scales the ordinate values of each plot so that the maximum ordinate has the value 0.5 or 1.0.

According to Figure 1., the executive routine RADAP reads input cards, reads file 1, writes on file 2, and calls the seven subroutines. These seven subroutines are called in the order as numbered in Figure 1.

Subroutine CMPSGH is called twice, once to compute and print the geoid height estimates (G.H.E.) and once to process the vertical deflection estimates (V.D.E.).

Subroutine STATCØM is also called twice, once to process geoid height residuals and once to process vertical deflection residuals. The printout by STATCØM consists of the residual statistics maximum, average, and standard deviation (G.H.S. and V.D.S.).

Printing is also done by subroutines GHCMPTS, DVCMPS, and STATCØM. GHCMPTS prints the geoid height weights (G.H.W.). DVCMPS prints out the vertical deflection weights (V.D.W.).

A plotting subroutine, PLØT, is called by subroutines GHCMPTS, STATCØM, and DVCMPS. Subroutine SCALE is called by the PLØT subroutine in order to establish a suitable graphical scale. Four graphical plots are produced by the program.

2.2 Detailed Description. Program RADAP will now be described in detail. To do this, a narrative description will be given for the program routines RADAP, TLIST, CHCMPTS, CMPSGH, STATCØM, DVCMPS, PLØT, and SCALE.

Within the narrative description, use is made of the routine variables as given in Appendix A. The narratives follow the macro-flowcharts for each routine as given in Appendix B.

Further information for each program routine is contained in the Extended Fortran IV program listings of Appendix C. Appendix D gives a sample set of program output. The output will be discussed more fully in Section 3.

2.2.1 RADAP Narrative Description.

a. This routine is the executive or control routine for the program flow during execution.

b. The routine functions as follows: At the start, the routine prints out three lines for program identification purposes. This identification defines the program by name, version number, and a title indicator for card data input. Next, the routine reads and prints the contents of the two input cards which contain radar analysis constants and controls.

Initialization of routine constants takes place and file (1) is rewound and read for the function selector value NFS. NFS can take on the values 1 through 5 and represents a geological feature simulated in the SARAS program. The NFS values are identified as follows:

NFS = 1 - symmetric ocean trough or crest
NFS = 2 - escarpment
NFS = 3 - inclined plane
NFS = 4 - sea waves, autocorrelated - Zondek method
NFS = 5 - sea waves, autocorrelated - Cohen method

The geological feature names require 2 or 3 words of Hollerith code to represent these titles and the printout of these names requires different formats. Files (1) and (2) are rewound. A test is now performed on the NFS value. If NFS is a 1 or 2, then IT = 3; where IT is the number of words describing the geological feature being processed. A test on IT will cause the program to go to the appropriate set of I/O statements to read and print the header record from file (1) that is associated with the geological feature defined by the value of NFS.

A test of the index IC, the option control for producing an output file, is made after the header record of file (1) is read. If IC = 0, then no output file is produced. Otherwise, the header record of file (1) is written on file (2) and it is also printed.

II, the total number of data points minus the number of filter fit points, is computed and is written on file (2) along with other values obtained from input card data. This written record on file (2) is the second header record and this information is also printed.

At statement 250, the RADAP routine calls the program subroutines in the order which follows:

TLIST,GHCMPTS,CMPSGH,
STATCØM,DVCMPS,CMPSGH,
STATCØM.

After all appropriate subroutines have been called and file (2) has been rewound, the library subroutines CRTID and EXITG are called to identify the graphical output and close out the plotting procedures. The program is then terminated.

c. The storage required by this routine is distributed as follows:

Program length	742_8	(482_{10})
Buffer length	12132_8	(5210_{10})
Common length	112202_8	(38018_{10})

2.2.2 TLIST Narrative Description.

a. TLIST reads the input data records 2 and 3 from file (1) into appropriate arrays for further program processing.

1. Record 2 consists of the x and YN arrays, where x ≡ Data Point Positions (km) and YN ≡ Nosiy Geoid Heights (m).

2. Record 3 consists of the Y and D arrays where Y $\equiv$ True Geoid Heights (m) and D $\equiv$ True Deflections of Vertical (arc sec).

b. After records 2 and 3 are read into the appropriate arrays, file (1) is rewound and control returns to the executive routine.

c. This subroutine has a storage length of 51_8 or 41_{10} words.

2.2.3 GHCMPTS Narrative Description.

a. The purpose of this subroutine is to compute and control the plotting of the geoid height filter weights.

b. Initially, the subroutine calculates and sets local program constants. The standard deviation of deflection ($\sigma_{N'}$) is converted from arc sec to radian measure. Standard deviation (σ_s) for a single point distance in meters is converted to kilometers. Next, the geoid height filter weights are computed and stored in array WN by a loop from 1 to LL. LL is equal to the number of filter fit points plus one.

These filter weight values are printed as part of the hardcopy output. Next, a call is made to the PLØT subroutine for plotting of the geoid height filter weights versus the along track distance. The program processing then returns to RADAP.

e. The program length is $244_8 (164_{10})$ and common storage is 111670_8 (37816_{10}).

2.2.4 CMPSGH Narrative Description.

a. This subroutine computes the geoid height or vertical deflection estimates $\hat{N}(x_i)$ or $\hat{N}'(x_i)$ depending on which one of the weights are in the WN array.

b. The argument list to this subroutine are defined as follows:

WN = array storage for filter weights
YNT = array storage for calculated geoid heights or vertical deflections
NP = two times number of filter fit points plus one
YN = array storage for noisy geoid heights
IC = 1, CMPSGH prints geoid height estimates;
= 2, CMPSGH prints vertical deflection estimates.

The first part of this subroutine initializes and computes local and global program constants.

Next, the counter J and the summation variable YNN are set. Computation is accomplished by a nested loop procedure. The inner loop

evaluates the appropriate sum for YNN. A continuation in the outer loop computes the geoid height or vertical deflection estimates and stores them in array YNT.

A test on the index IC is made and the appropriate estimates $\hat{N}(x_i)$ or $\hat{\hat{N}}(x_i)$ are printed and the subroutine ends. The printout is done with the CDC computer system library routine PDUMP. Each estimated value has an associated storage location value printed also.

c. Subroutine storage is $142_8(98_{10})$ and common length is $20_8(16_{10})$.

2.2.5 STATCØM Narrative Description.

a. This subroutine computes the residual statistics for geoid heights or vertical deflections. The statistics computed for a set $\{\Delta s_i\}$ are the residual maximum, average, and standard deviation; designated respectively by $|\text{MAX } \Delta s_i|$, $\overline{\Delta s}$, and σ.

b. First, a test is made on the index IC. If IC = 1, the geoid height residuals are computed. IC = 2 means that the vertical deflection residuals are computed. A test of index IIC is made if the residuals are to be written on the output file (2). IIC $\neq$ 0 implies that the output file is written. This test is made for both types of residuals.

The next operation involves finding the maximum absolute value of the residuals. A calculation for the average value of the residuals is then performed followed by a calculation of the residual standard deviation.

Another test of index IC is made for printing and plotting the appropriate residuals and residual statistics. STATCØM processes only one type of residuals each time it is called from RADAP.

c. Subroutine length is $301_8(193_{10})$ and common length is 111670_8 (37816_{10}).

2.2.6 DVCMPS Narrative Description.

a. The purpose of this subroutine is to compute and control the plotting of the vertical deflection filter weights.

b. DVCMPS has the same sequence of events as subroutine GHCMPTS. See the narrative description of GHCMPTS.

c. Subroutine storage required is $301_8(193_{10})$ for program length and $111670_8(37816_{10})$ for common length.

2.2.7 PLOT Narrative Description.

a. This subroutine acts as the control for writing the title, labeling the axes, and plotting the points for each graph. Details of the graphical subroutines used by PLOT are contained in Reference 4. The subroutine argument list is defined as follows:

ZN = ordinate array for storage of true geoid heights, true vertical deflections, weighted geoid heights, or weighted vertical deflections
X = data point position abscissa array
NL = number of data points to be plotted
LT = graph number
LT1 = number of plots per graph (1 or 2).
NFS = selector for geological feature
LK = location for GRF argument M.

The PLOT subroutine has the capability of plotting any of the following ordinate value arrays versus along track distance (x_1):

(a) weighted geoid height
(b) weighted vertical deflection
(c) true geoid height and geoid height residuals (on the same graph)
(d) true vertical deflection and vertical deflection residuals (on the same graph)

However, only one of the above are processed at each call to PLØT. Titling of plots is dependent upon the following values of plot number LT:

1 - weighting function for geoid height
2 - weighting function for vertical deflection
3 - true geoid height and geoid height residuals
4 - true vertical deflection and vertical deflection residuals

b. The first executed statement in the subroutine is a call to the library subroutine MODESG. This initial call to MODESG sets the Z array to the default values as used by the plotting subroutines.

A test is performed on the value of LT. LT > 1 implies that this is the second pass through the subroutine PLOT and the plot identification procedures are by-passed. If LT = 0 or 1, then it is the first pass through PLOT and the film identification is read from an input card. A call is now made to the film identification subroutine CRTID. Another input card is read which contains thirty alphanumeric characters which define the graph title, noise type and standard deviation, and the plot interval.

Next, the maximum absolute ordinate value is determined from ordinate array ZN. Index LT1 is now tested. When LT1 = 1, then there is

only one plot per graph. If LT1 = 2, then there are two plots per graph and the maximum absolute ordinate value must be determined from both sets of data; the true values and their residuals (ZN and WN arrays).

The maximum and minimum abscissa values are now found. And next, the SCALE subroutine is called so that the scale factor KE can be determined so that a new convenient maximum ordinate of 0.5×10^x or 0.1×10^x, where x is the appropriate exponential power, is defined.

The graphical axis origin is now set in locations XØR and YØR. DX and DY are set for the abscissa and ordinate tick mark spacings. Scale factor KE is now stored in a floating point location R.

Another test is now performed on the index LT1 for scaling purposes. If LT1 = 2, then there are 2 plots/graph. The residuals and the ordinate values contained in the ZN array are scaled and stored in the WN and ZW arrays, respectively. If LT1 = 1, only the ZN array is scaled for plotting. Other plot control values are also initialized before setting up the graphical subject and object spaces.

At statement 300, the subject space is established in raster units and the object space is established in normalized units. For plot control, calls to SETSMG are necessary for updating the Z array before calls to the subroutine TITLEG. Calls to NUMBRG and LEGNDG are made in order to print the scale factor on the graph at a particular location. The control variable LT selects the appropriate graphical plot labeling depending on the number of the graph being plotted.

After plotting one of the graphs, the processing goes to statement 700. Here, the object space is reset and a call is made to GRF. Library subroutine GRF puts on the axis and plots one curve on the graph.

If LT1 = 1, then the processing skips a call to GRF since no residuals are plotted. After statement 750, a call to library subroutine PAGEG (skips to next graphical page) is made and the subroutine PLØT returns control to RADAP.

c. Storage needs are 16015_8 (7181_{10}) words for program length and 112200_8 (38016_{10}) words for common length.

2.2.8 SCALE Narrative Description.

a. This subroutine is used to scale the ordinate values to be plotted so that the maximum ordinate has the value 0.5 or 1.0 appearing on the graph. The appropriate exponent is also determined for labeling of the graphical ordinate scale.

b. Initially the variable I, used to store the integer exponent of the maximum ordinate YMA, is set to zero. The decimal part of YMA is set between -1.0 and 0.0.

The exponential part of YMA is stored into location I. If the decimal part of YMA is between -0.5 and 0.0, then the graphical ordinate value YMI is set equal to -0.5. Otherwise, YMI = -1.0 and the program processing returns to subroutine PLØT.

c. Storage subroutine length is $63_8 (51_{10})$ words.

2.3 Processing Time.

The computer time necessary to process a total of 6251 data points is 164 central processor seconds (CPS). This time estimate includes the time for the generation of an output file.

Compilation time for this program is 14.0 CPS.

SECTION 3. INPUT/OUTPUT DESCRIPTION

3.1 General Description. This program utilizes input data from a permanent file and IBM cards. The permanent file is generated by the SARAS program described in Reference 1. In addition, the RADAP program can now process real satellite radar altimetry data if it is in the appropriate input format.

Input card data contains information about simulated satellite radar altimeter observations. Card data also contains design values for the Weiner-Kolmogoroff filter.

RADAP output consists of hard copy printout, four graphs, and an output file, on option.

3.2 Characteristics, Organization, and Detailed Description of System Data.

3.2.1 General Characteristics. During program execution, the input to the program consists of 80 column IBM cards and a permanent file. Output of the program includes hard copy printout, a permanent file (on option), and four separate sheets of graphical output.

a. Routine RADAP first prints out the program identification. It then reads and prints out the input card data. It also reads and prints out the header record from the input permanent file, SARAS data. If the output permanent file option is on, then RADAP writes and prints out the first two header records.

Subroutine TLIST reads the remaining two data records from the input data file into appropriate arrays for further processing.

Subroutine GHCMPTS prints and sets up the call to plot the geoid height weights.

CMPSGH prints the hard copy of geoid height estimates or vertical deflection estimates.

STATCØM prints out the statistics for the residuals and initiates a call to plot true values and residuals for either geoid heights or vertical deflections.

DVCMPS prints and initiates the call to plot vertical deflection weights.

Subroutine PLØT reads the last two input data cards and actually calls the graphical plotting library subroutines.

b. Input data cards convey information to the program RADAP of the following types:

1. Program constants needed to evaluate the filter.

2. Control option for writing permanent output file.

3. Film identification, data for graph title, and a plot interval numerical value.

The input permanent file, SARAS data, contains simulated satellite altimeter observations to be processed by the program. Hard copy printout and graphical output is used for both monitoring and evaluating the filter qualities.

A permanent output file which contains the geoid height and vertical deflection residuals is used by other computer programs for further analysis (e.g. harmonic analysis).

c. Input data to the program is of a fixed or static type. The program does not alter or modify this data in any way.

d. Storage requirements for the input and output files are about 38000_8 words.

e. The input permanent file data is limited to 43000_8 words since the program loading and execution uses 211000_8 words.

3.2.2 Organization and Detailed Description. The internal structure for each input/output component will now be discussed. In addition, a set of sample output given in Appendix D will be described.

Input data cards are described as follows:

Card 1: Program constants read by the RADAP routine.

Column	Variable	Description	Format
1-25	BRDC	Inverse Correlation Distance (1/km)	E25.14
26-50	SDD	Single Pulse Radar Standard Deviation (m)	E25.14
51-55	NFS	Function Selector	I5
56-60	LSX	Filter Fit/Data Spacing	I5
61-65	IC	Output File Option 0=no file, 1=output file	I5

Card 2: Program constants read by the RADAP routine.

Column	Variable	Description	Format
1-25	SDV	Deflection Standard Deviation (arcsec)	E25.14
26-50	FDS	Data Spacing (km)	E25.14
51-60	LFSP	½ Number of Filter Fit Points	I10

Card 3: Film identification read by subroutine PLØT

Column	Variable	Description	Format
1-20	H	Film Identification: NWXY - columns 1-4 XY is programmer number XXXX - columns 5-8 program name XXXX - columns 9-12 office room number XXXXXXXX - columns 13-20 calendar date	2A10

Card 4: Graph title data and plot interval as read by subroutine PLØT

Column	Variable	Description	Format
1-30	DA	Thirty Alphanumeric Characters for Graph Title	3A10
31-60	TN	Noise Type and Standard Deviation (m)	3A10
61-65	IP	Plot Interval, i.e. Plots Every IP^{th} Point From the Data Set	I5

The structure for the input permanent file, SARAS data, can be found in Reference 1, page B-8.

An output file, in binary form, is produced if the output control option IC=1. The internal structure of the output file is as follows:

Record 1. Header Record (1)

Word #	Word Content	Word Format	Description
1	NFS	I	Function selector
2	NR	I	Run number
3	DATE	A	Calendar date
4-5 or 4-6	B(I)	A	Geodetic feature (number of words depends on NFS)
6 or 7	NGS	I	Noise type generator
7 or 8	SN	F	Noise standard deviation
8 or 9	N	I	Total number of data points

Record 2. Header Record (2)

Word #	Word Content	Word Format	Description
1	NFS	I	Function selector
2	BRDC	F	Inverse correlation distance
3	SDD	F	Single pulse radar standard deviation
4	LSX	I	Filter fit/Data spacing
5	SDV	F	Deflection standard deviation
6	FDS	F	Data spacing
7	LFS	I	Number of filter fit points
8	II	I	Total number of data points minus total number of filter fit points

Record 3. Data Record

Word #	Word Content	Word Format	Description
1	NP	I	Number of data points
2	WN	F	Geoid height residual array
3	WN	F	
.		.	
.		.	
.		.	
NP + 1	WN	F	

Record 4. Data Record

This record has the same structure as record 3 except that the array values are vertical deflection residuals.

The hard copy print out and the graphical output of the program will now be described. A sample of program output is contained in Appendix D.

On page 1 of Appendix D appears the program identification. This is printed from the RADAP routine and includes the program name, version, and date. At the top of the next page appears the title of the output data. The next 9 lines gives the input card data as printed from the RADAP routine.

A printout of the header record as read from the input file is contained in the next two lines. Following in the next 3 lines is the header records for the output file. Both input and output file header records are printed from routine RADAP.

The next set of data is printed from Subroutine GHCMPTS. This printout contains the values for geoid height weights and are read across the page for each line. This is a PDUMP which begins at octal location 061260_8 and ends at 063240_8.

The next 2 lines of printout are input card data as printed from Subroutine PLØT. Each line of values are identifiable from the printout.

A PDUMP for the geoid height estimates are printed from Subroutine CMPSGH beginning at octal location 075514_8 and ending at 103000_8.

Geoid height residual statistics appear on the next 3 lines and are clearly identified by titles. These values are printed from Subroutine STATCØM.

Now, the same PDUMP printout follows for the vertical deflections as given above for the geoid heights. Subroutine DVCMPS prints out the vertical deflection weights. The vertical deflection estimates are printed from Subroutine CMPSGH. STATCØM now prints out the vertical deflection residual statistics.

The last two lines of printout are provided by the system library graphical routines. This information informs the programmer as to the status of the graphical output. A detail explanation of this printout can be found in Reference 4, pages 4-50 to 4-53.

After the printout, the graphical output appears as shown in Appendix D. Four graphical plots are produced. The first two graphs are plots of geoid height and vertical deflection weights versus the along track distance.

Graph number three contains two separate plots. One curve is a plot of true geoid heights versus along track distance. The other curve on the same ordinate scale is a plot of the geoid height residuals versus along track distance.

The fourth graph is similar to the third graph except that the ordinate values apply to true deflection of vertical and deflection of the vertical residuals.

References:

1. Generation of Simulated Satellite Radar Altimeter Observations, Samuel L. Smith III, Henry E. Castro, NWL Technical Report TR-3004, April 1973.

2. Numerical Simulation of Stochastic Processes, Dr. Bernd Zondek, NWL Technical Report TR-2614, October 1971.

3. Recovery of Deflection of the Vertical From Simulated Satellite Radar Altimeter Data, Charles J. Cohen, and Samuel L. Smith III, NWL Technical Report TR- (to be published).

4. Programmer's Reference Manual for the Integrated Graphics, Software System, Vol. 1, No. 9500360.

Appendix A

Definition of Program Variables

RADAP

B - An array which contains the name of the geological feature being processed.

BRDC - Inverse correlation distance (1/km)

D - An array used to store the true vertical deflections

DATE - Calendar date of input file data

FDS - Data spacing (km)

I - Do loop integer variable

IC - Output file option control index

IGF - Lower do loop index variable

II - Numerical value of total number of data points minus number of filter fit points

IT - Upper do loop index variable

L = LFSP - ½ number of filter fit points

LFS - Number of points for filter fit plus 1

LSX - One filter fit/data spacing

N - Total number of data points

NFS - Variable which depends on the geological feature being processed (see reference 1, page B-8)

NGS - Noise type generator (see reference 1, page B-8)

NR - Input file run number (see reference 1, page B-8)

SDD - Single pulse radar standard deviation (meters)

SDV - Deflection standard deviation (arc sec)

SN - Noise standard deviation (see reference 1, page B-8)

TLIST

D - Array for smooth vertical deflection values

X - Array for along track distance values

Y - Array for smooth geoid height values

YN - Array for noisy geoid height values

GHCMPTS

AR - Temporary storage variable

BRDCQ - Cube of inverse correlation distance

BRDCS - Square of inverse correlation distance

DR - Temporary storage variable

F - Temporary storage variable used to calculate filter weight

FDS1 - Temporary storage of a count value (J) times data spacing; $-LFSP \leq J \leq LFSP$.

I - Do loop variable

ID - Variable used to store the number of data points taken up by number of filter points

IL - Total number of data points on one side of middle minus number of points taken up by filter fit points plus 1.

J - Variable counter, $-LFSP \leq J \leq LFSP$.

LL - Two times number of filter fit points, plus one

LM - Number of data points on either side of zero

NP - Common storage location for value of LL

R - Temporary storage used in calculations

RJ - Local variable used in calculation of filter weights

RM2 - Storage location for value of R-2

RNR - Storage location for 16 times deflection variance

RRR - Storage location for $2\sqrt{1 - R + R^2}$

RS - Storage location for R^2

R1 - Storage location for $.5[R - 2 + 2\,(1 - R + R^2)^{\frac{1}{2}}]^{\frac{1}{2}}$

R1A - Temporary storage of intermediate calculation

R1RJ - Temporary storage used in calculation of filter weights

R2 - Storage location for $.5[-(R-2) + 2(1-R + R^2)^{\frac{1}{2}}]^{\frac{1}{2}}$

R2RJ - Temporary storage used in calculation of filter weights

R6 - Storage location for R/6

SDD - Storage location for 1×10^{-3} times single pulse radar standard deviation

SDDS - Storage location for square of SDD

SDV - Storage location for $4.84136811 \times 10^{-6}$ times standard deviation of deflection

SDVS - Storage location for square of SDV

SJ - Temporary storage used in calculation of filter weight

SRA - Storage location for $(1.- R - R^2)^{\frac{1}{2}}$

SRB - Storage location for $(1. + R)^{\frac{1}{2}}$

SRB1 - Temporary storage used in calculation of filter weights

SR3 - Storage location for the constant 1.732050803

WN - Array storage for geoid height filter weights

CMPSGH

I - Do loop variable

IA - Variable used to sequence the filter points

IL - Number of filter fit points plus one

J - Variable counter

K - Do loop variable

NPT - Variable for total number of data points minus the total number of filter fit points

NT - Variable for total number of data points minus ½ number of filter fit points

NZ - NPT

YNN - Summation variable for geoid height or vertical deflection calculations

YNT - Array for calculated geoid heights or vertical deflections

STATCØM

AVE - Local variable used for storage of average geoid height or average vertical deflection residual.

AXDS1 - Storage location for the maximum value of geoid height or vertical deflection residual

AXDS2 - Storage location for the minimum value of geoid height or vertical deflection residual

AX1 - Storage location for the absolute value of AXDS1

AX2 - Storage location for the absolute value of AXDS2

M - Storage location of 1, used in PLØT argument list

SS - Summation variable used to compute standard deviation of geoid height or vertical deflection residual

WN - Array used to store geoid height or vertical deflection residuals

DVCMPS

Definition of variables have same meaning as used in GHCMPTS except that deflection of vertical calculations are performed.

PLØT

DA - Storage location for geological feature being processed

DX - Storage location of the scaled minimum value for the graph abscissa

DY - Storage location of the scaled maximum value for the graph ordinate

H - Storage location of the film identification

I - Do loop variable

IP - Storage location for the plot interval

IT - Storage location of -1, used in GRF argument list

LA - Storage location of IP value, used in GRF argument list

LK - Storage location of IL value, used in GRF argument list

LØ - Storage location of IP value, used in GRF argument list

LTT - Local variable, storage for number of points in ZN array

M - Storage location for 0 or 1, used in GRF argument list

ML - Storage location for the value of the number of points to be plotted, used in GRF argument list

MP - Same use as ML above

R - Storage location for the exponent of the scale factor which appears on graph

TN - Storage location for Gaussian constant which appears on graph

XHI - Storage location for maximum abscissa object size

XLØ - Storage location for minimum abscissa object size

XMA - Storage location for maximum value of graph abscissa, used in call to GRF argument list

XMIN - Minimum value of graph abscissa, used in call to GRF argument list

XØR - Same as for XMIN above

X10 - Storage location for Hollerith data which goes on graph

YHI - Storage location of maximum graphical object size

YLØ - Storage location of minimum graphical object size

YMA - Storage location at maximum ordinate, used in GRF argument list

YMX - Storage location of maximum value of residual, used in GRF argument list

YM1 - Storage location for the ordinate absolute minimum

YM2 - Storage location for the ordinate absolute maximum

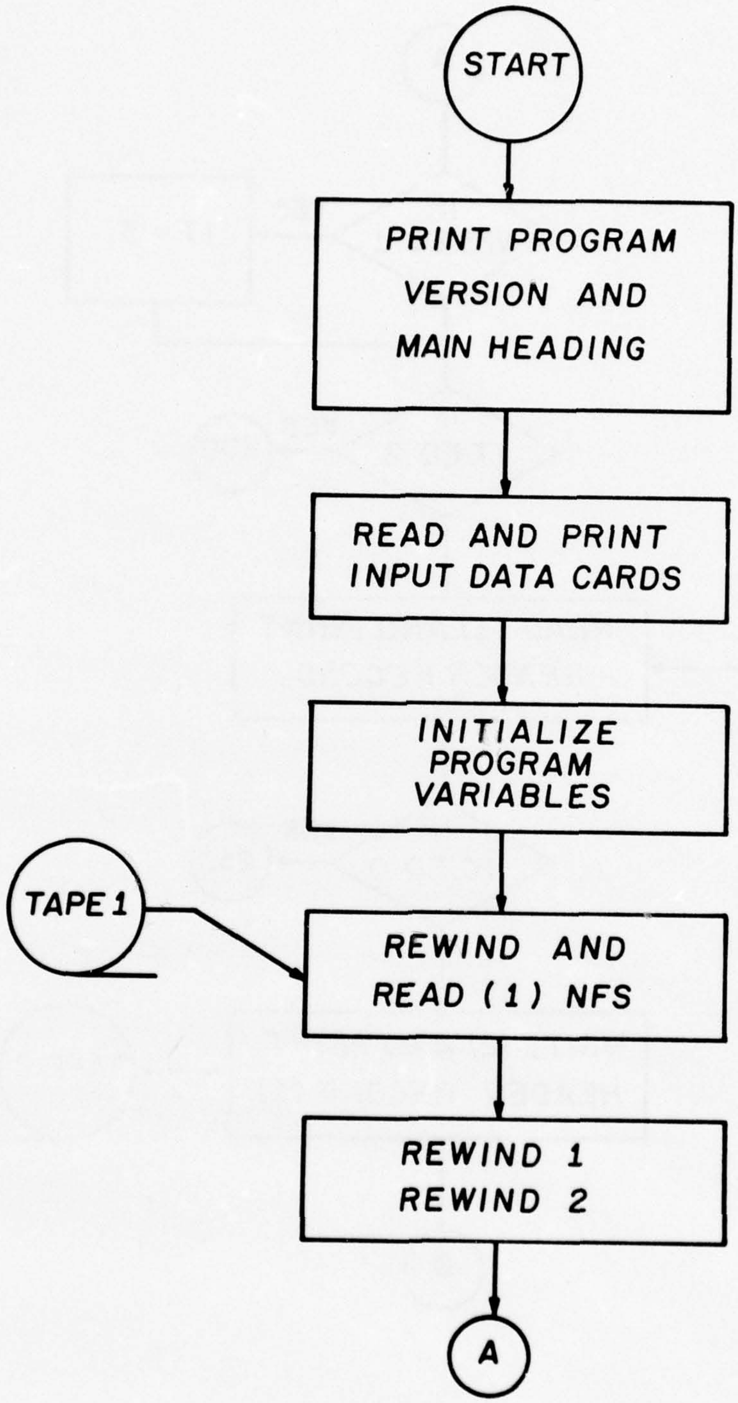
YØR - Ordinate value of graphical origin (0); used in GRF argument list

ZW - Array containing the scaled residuals to be plotted

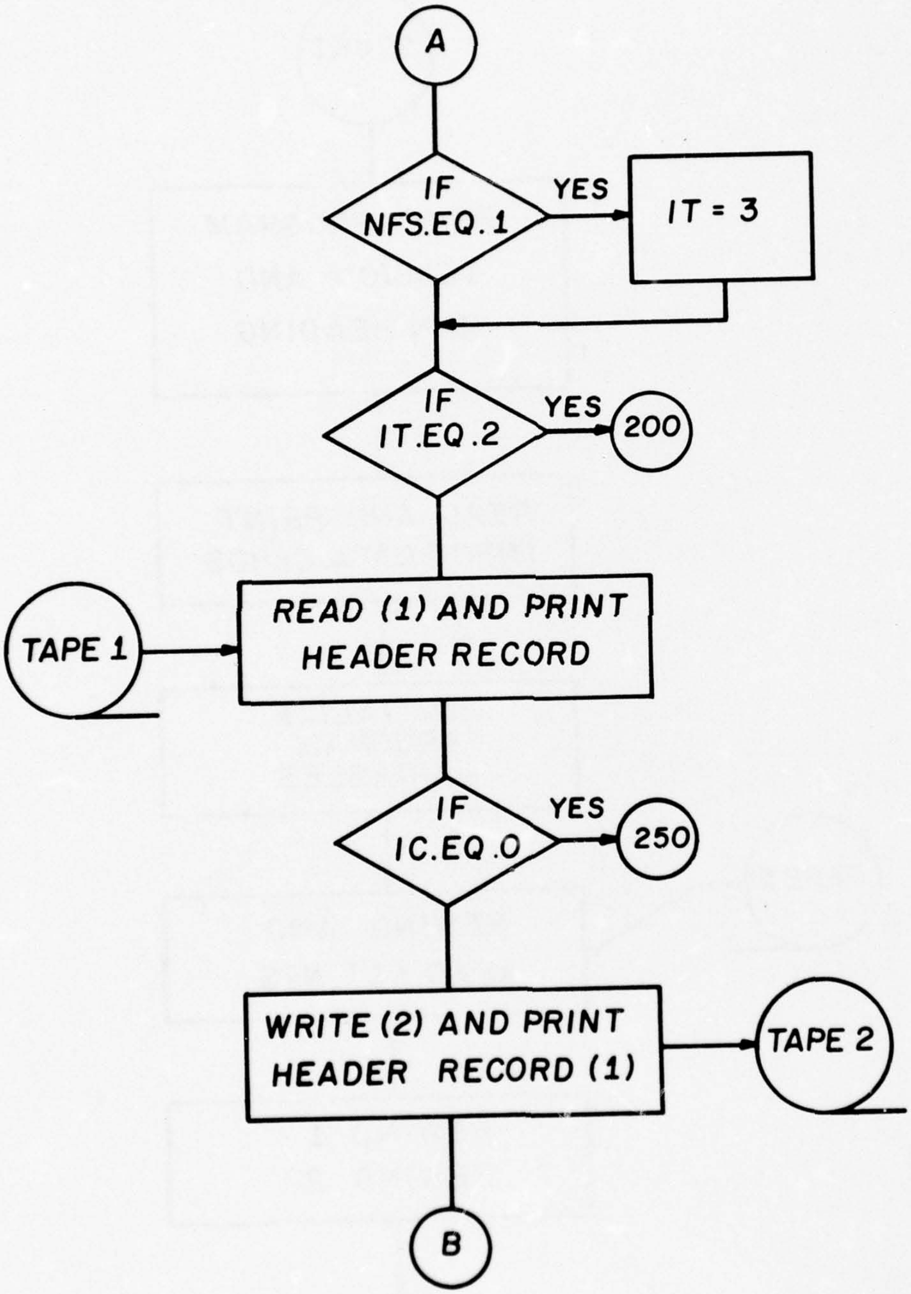
Appendix B

Program Macro-Flowcharts

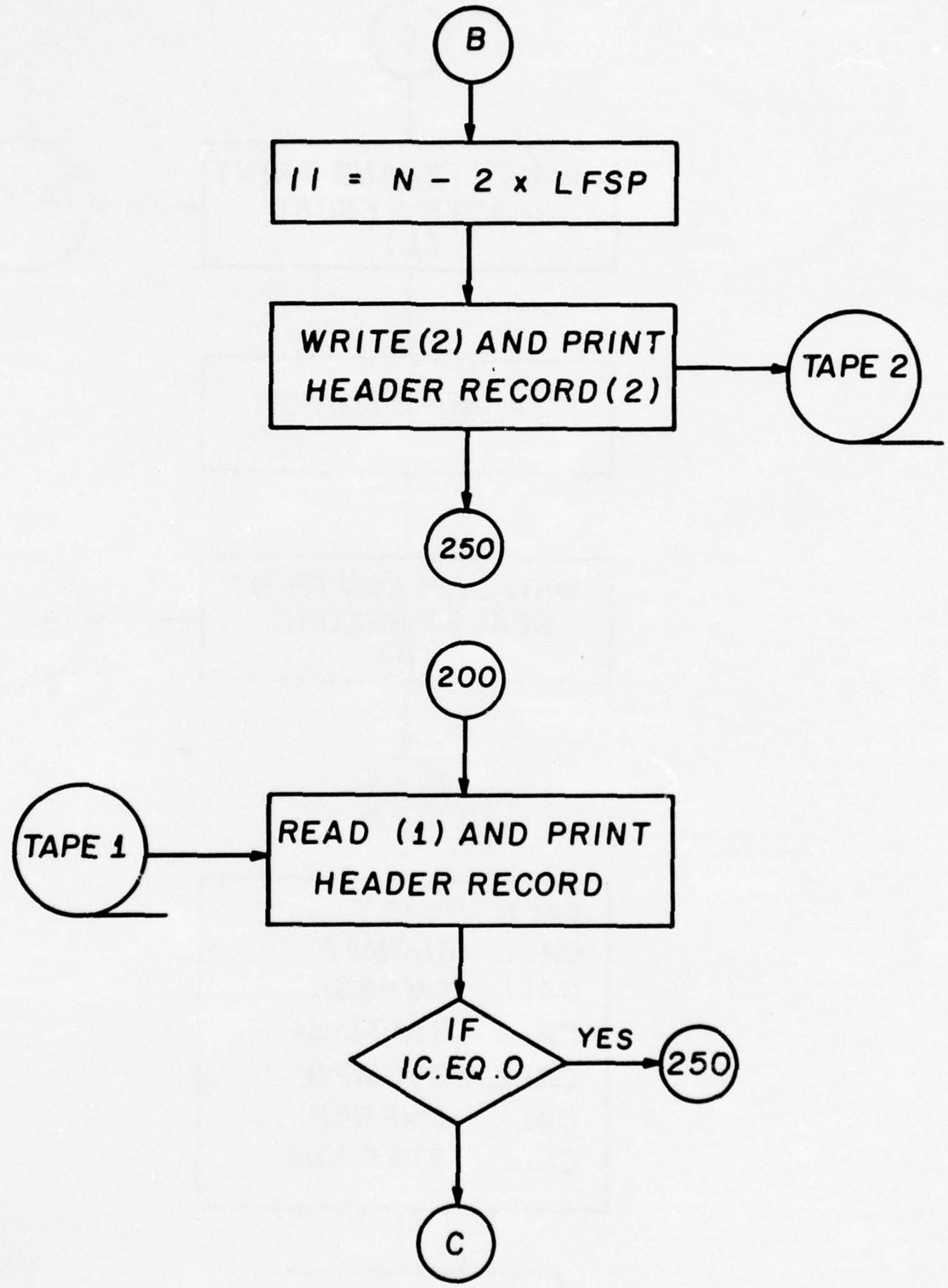
RADAP


START
PRINT PROGRAM VERSION AND MAIN HEADING
READ AND PRINT INPUT DATA CARDS
INITIALIZE PROGRAM VARIABLES
TAPE 1
REWIND AND READ (1) NFS
REWIND 1
REWIND 2
A

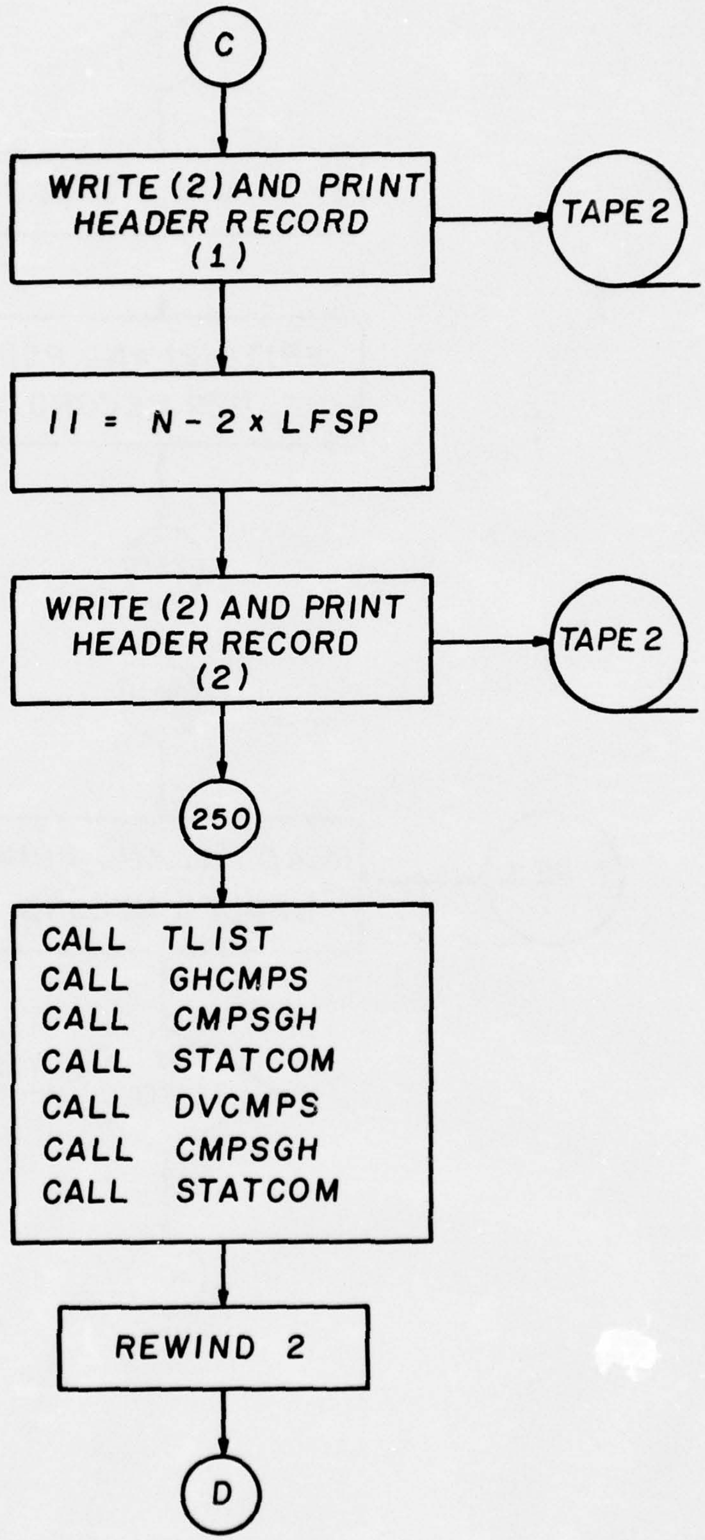
RADAP


A
IF
NFS.EQ.1
YES
IT = 3
IF
IT.EQ.2
YES
200
TAPE 1
READ (1) AND PRINT
HEADER RECORD
IF
IC.EQ.0
YES
250
WRITE (2) AND PRINT
HEADER RECORD (1)
TAPE 2
B

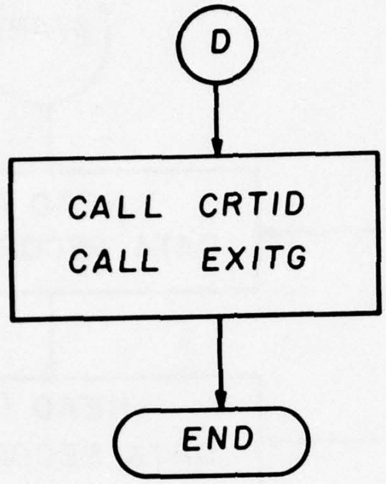
RADAP


B
II = N - 2 x LFSP
WRITE (2) AND PRINT HEADER RECORD (2)
TAPE 2
250
200
TAPE 1
READ (1) AND PRINT HEADER RECORD
IF IC.EQ.O
YES
250
C

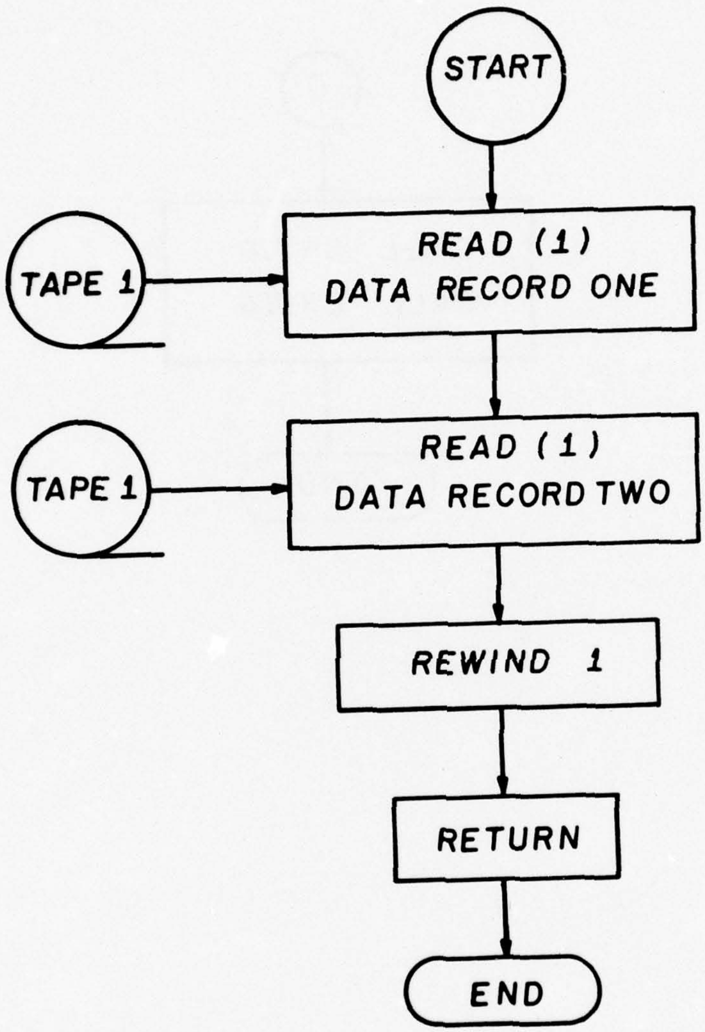
RADAP


C
WRITE (2) AND PRINT HEADER RECORD (1)
TAPE 2
I1 = N - 2 x LFSP
WRITE (2) AND PRINT HEADER RECORD (2)
TAPE 2
250
CALL TLIST
CALL GHCMPS
CALL CMPSGH
CALL STATCOM
CALL DVCMPS
CALL CMPSGH
CALL STATCOM
REWIND 2
D

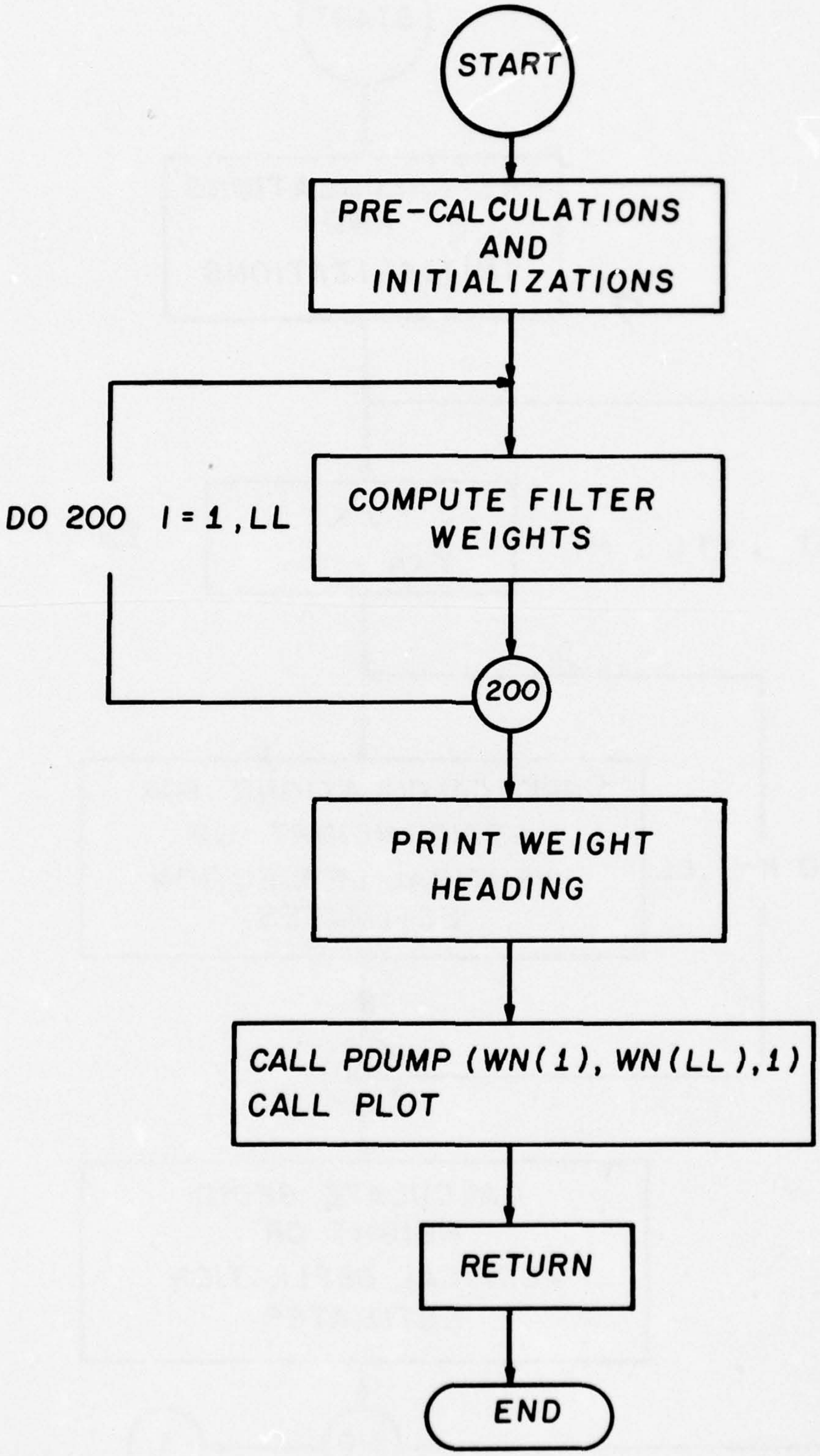
RADAP



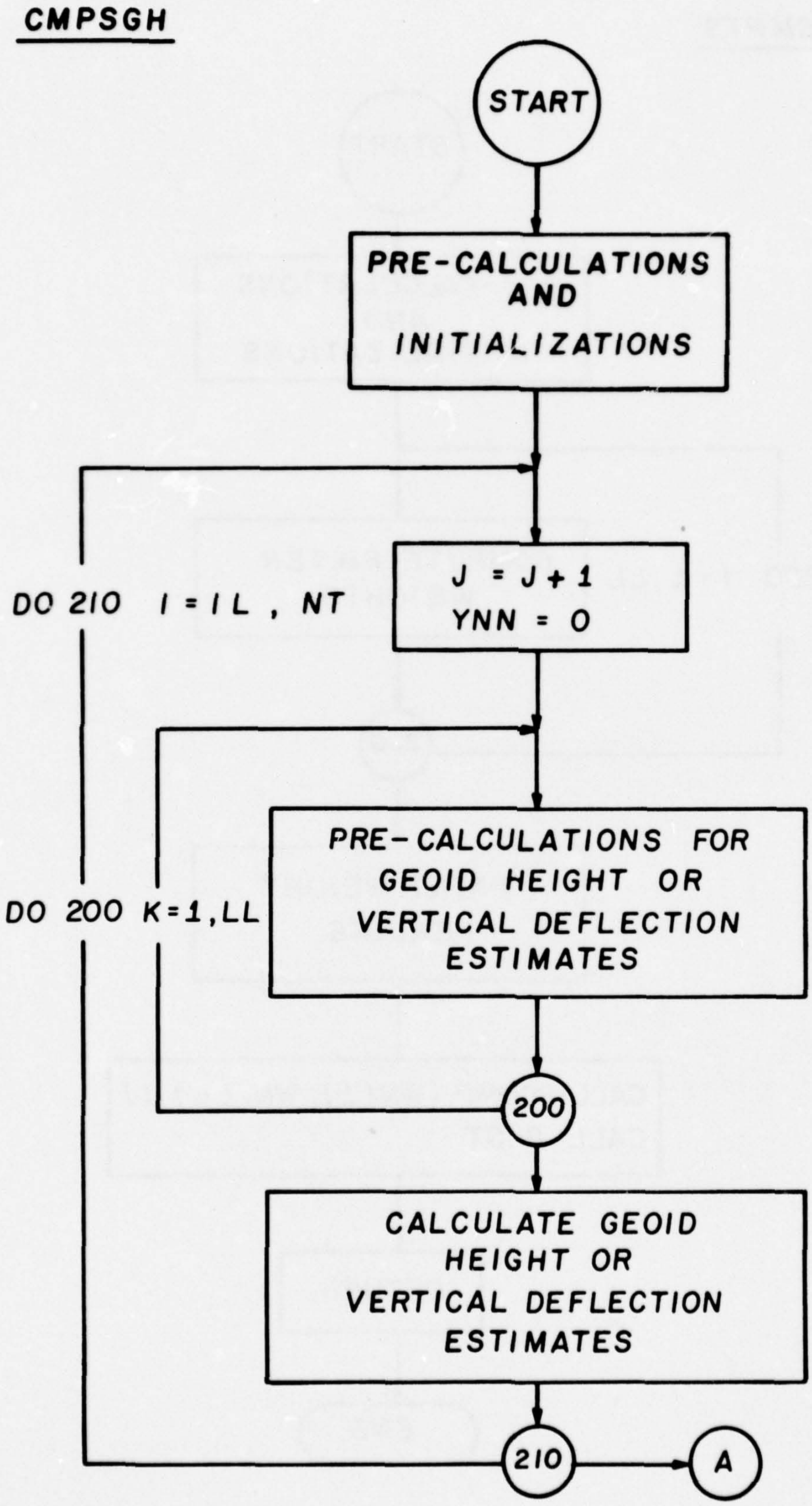
TLIST


START
TAPE 1
READ (1)
DATA RECORD ONE
TAPE 1
READ (1)
DATA RECORD TWO
REWIND 1
RETURN
END

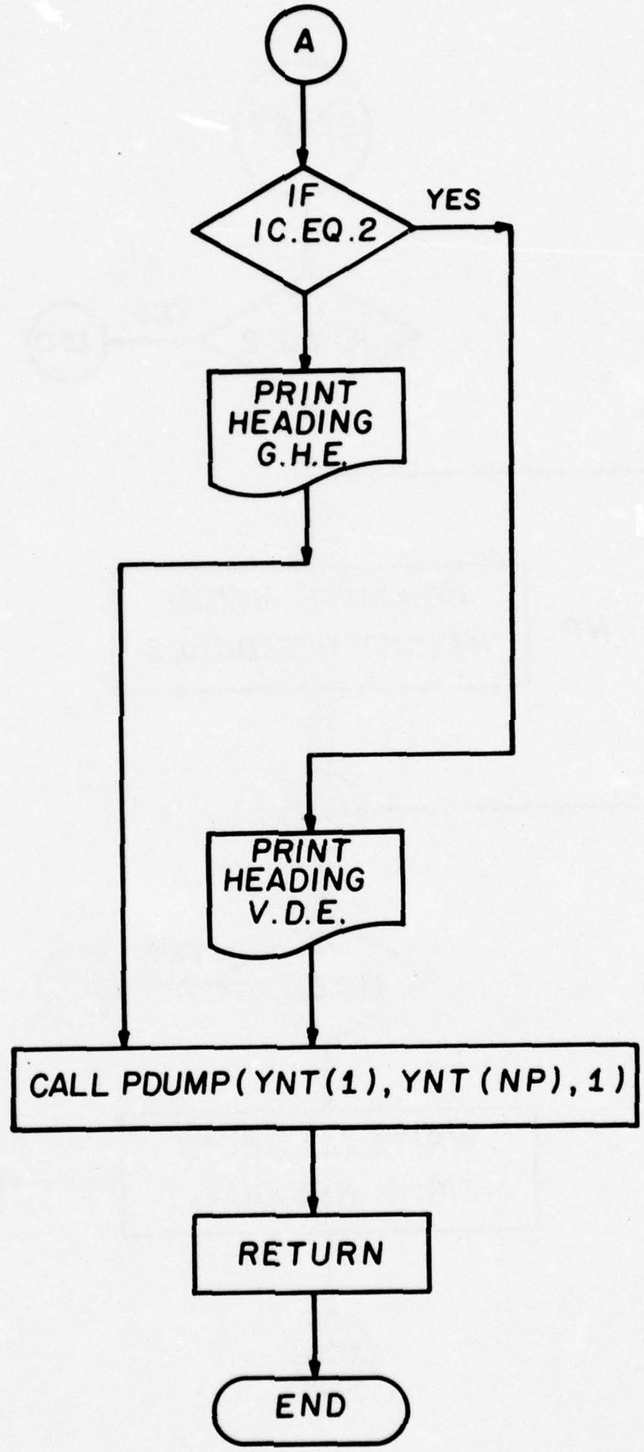
GHCMPTS



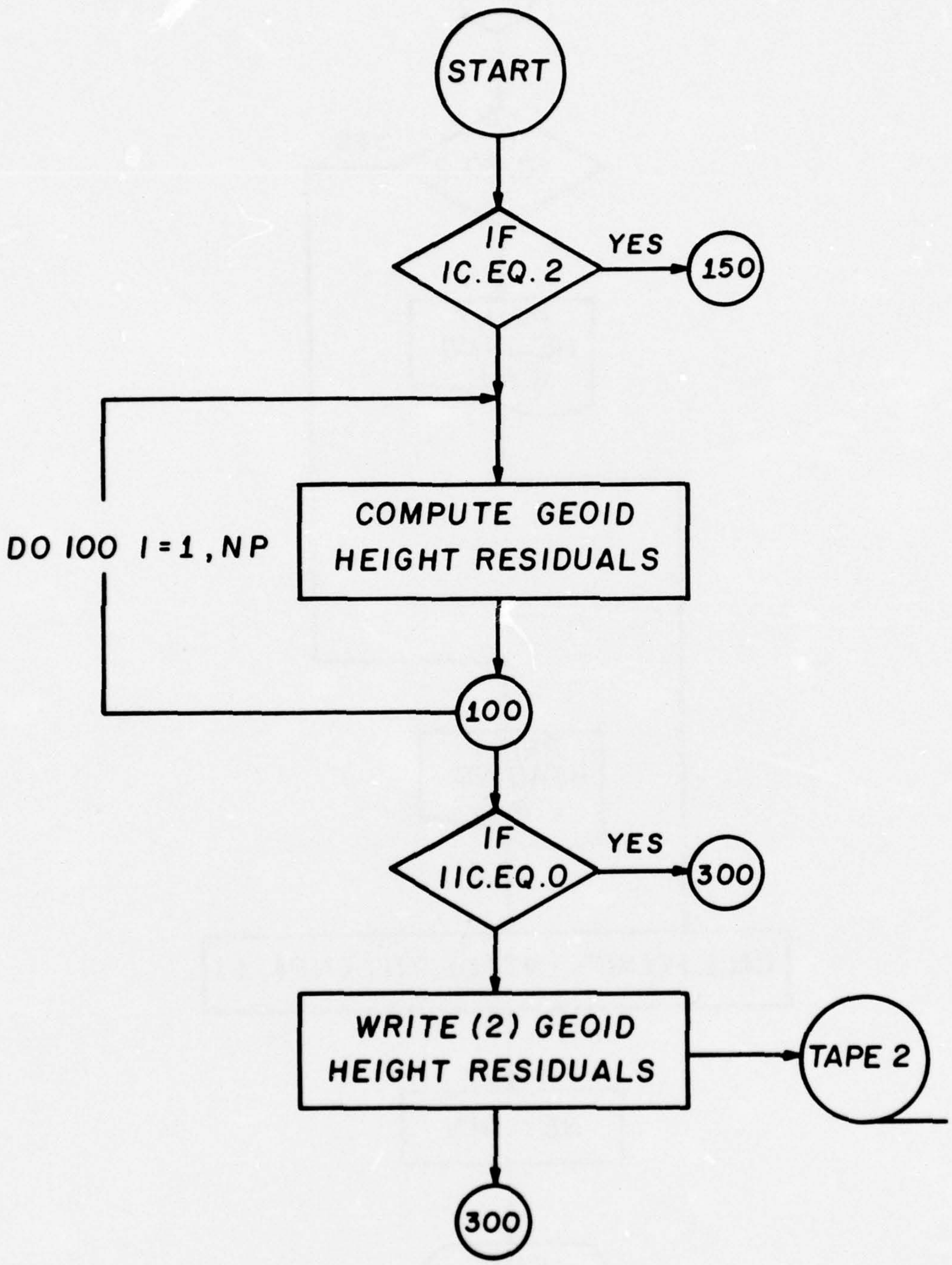
START
PRE-CALCULATIONS AND INITIALIZATIONS
DO 200 I = 1, LL
COMPUTE FILTER WEIGHTS
200
PRINT WEIGHT HEADING
CALL PDUMP (WN(1), WN(LL), 1)
CALL PLOT
RETURN
END


CMPSGH
START
PRE-CALCULATIONS AND INITIALIZATIONS
DO 210 I = IL , NT
J = J + 1
YNN = 0
DO 200 K = 1, LL
PRE-CALCULATIONS FOR GEOID HEIGHT OR VERTICAL DEFLECTION ESTIMATES
200
CALCULATE GEOID HEIGHT OR VERTICAL DEFLECTION ESTIMATES
210
A

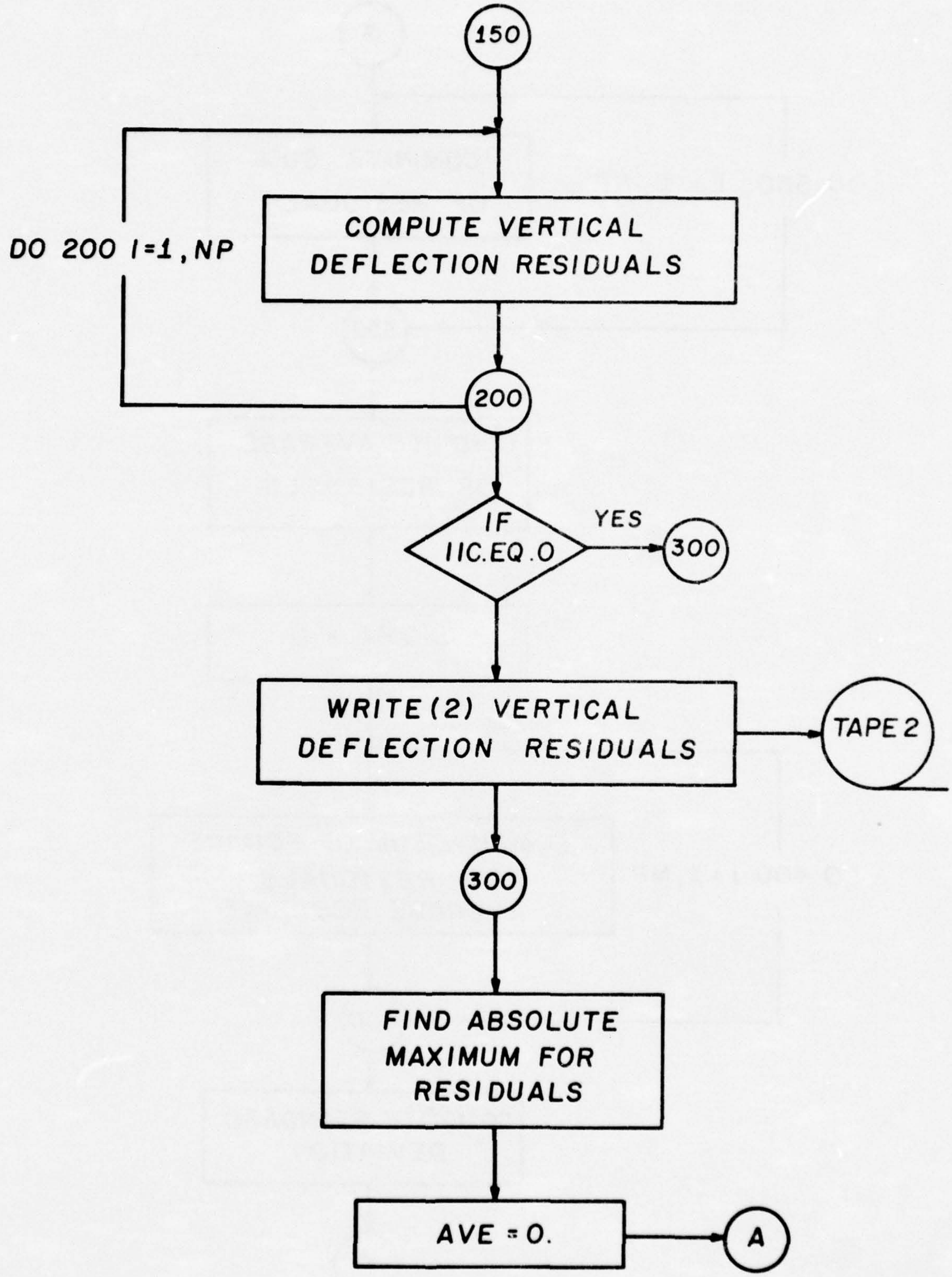
CMPSGH


A
IF
IC.EQ.2
YES
PRINT
HEADING
G.H.E.
PRINT
HEADING
V.D.E.
CALL PDUMP(YNT(1),YNT(NP),1)
RETURN
END

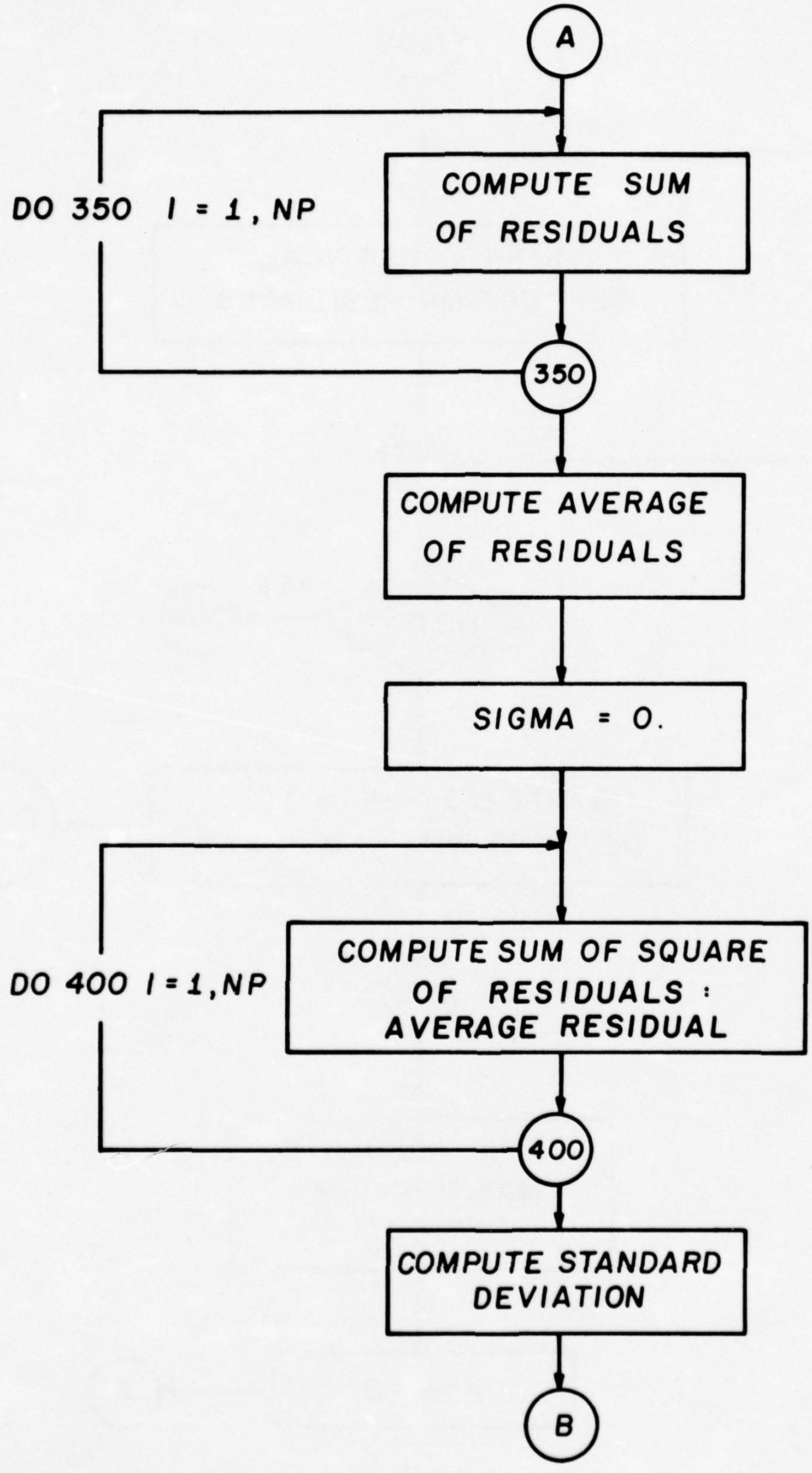
STATCOM


START
IF IC.EQ.2
YES
150
DO 100 I=1,NP
COMPUTE GEOID HEIGHT RESIDUALS
100
IF IIC.EQ.0
YES
300
WRITE (2) GEOID HEIGHT RESIDUALS
TAPE 2
300

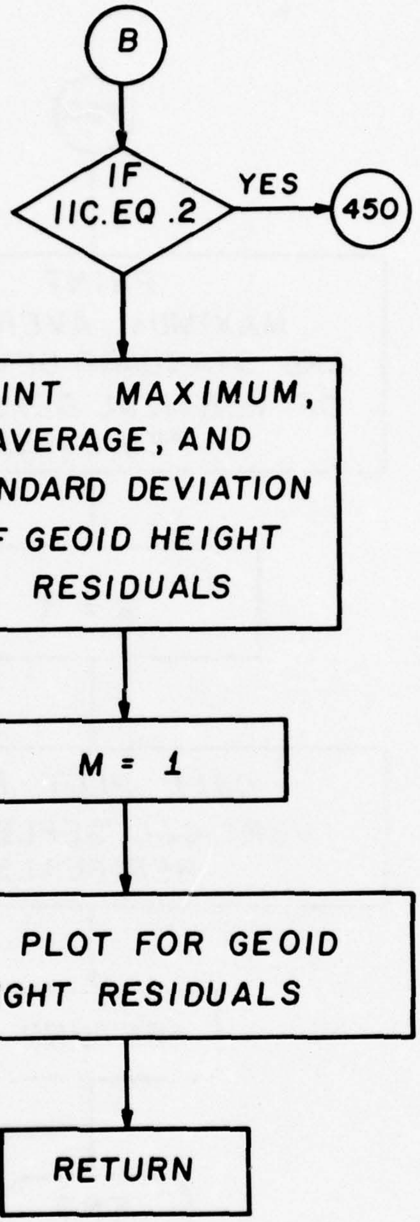
STATCOM


150
DO 200 I=1, NP
COMPUTE VERTICAL DEFLECTION RESIDUALS
200
IF IIC.EQ.O
YES
300
WRITE (2) VERTICAL DEFLECTION RESIDUALS
TAPE 2
300
FIND ABSOLUTE MAXIMUM FOR RESIDUALS
AVE = 0.
A

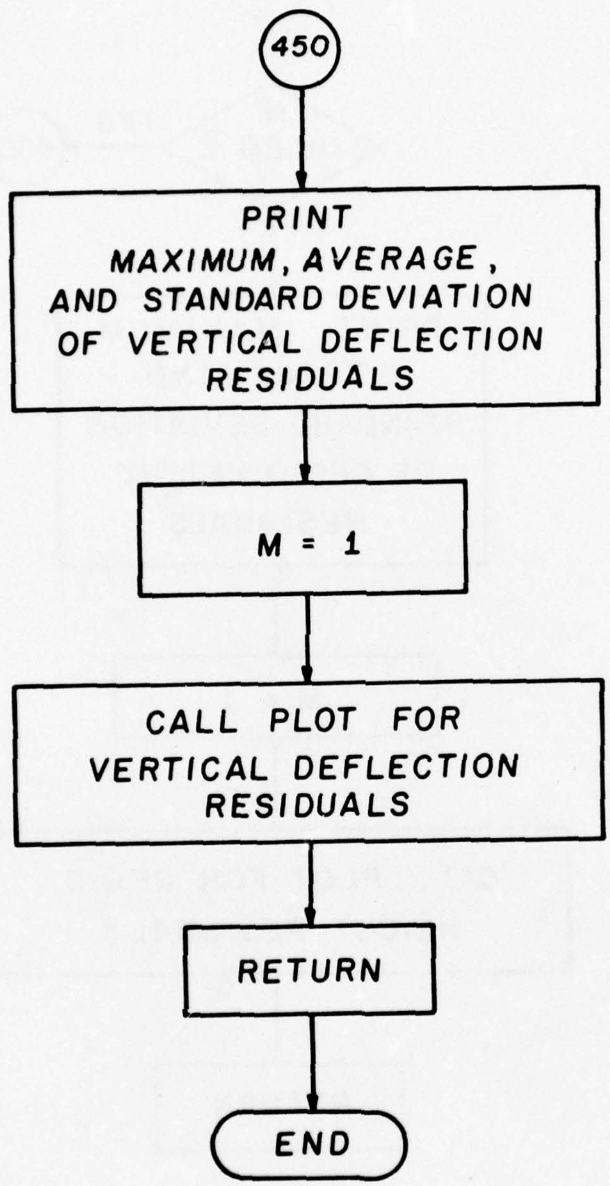
STATCOM


A
DO 350 I = 1, NP
COMPUTE SUM OF RESIDUALS
350
COMPUTE AVERAGE OF RESIDUALS
SIGMA = 0.
DO 400 I = 1, NP
COMPUTE SUM OF SQUARE OF RESIDUALS : AVERAGE RESIDUAL
400
COMPUTE STANDARD DEVIATION
B

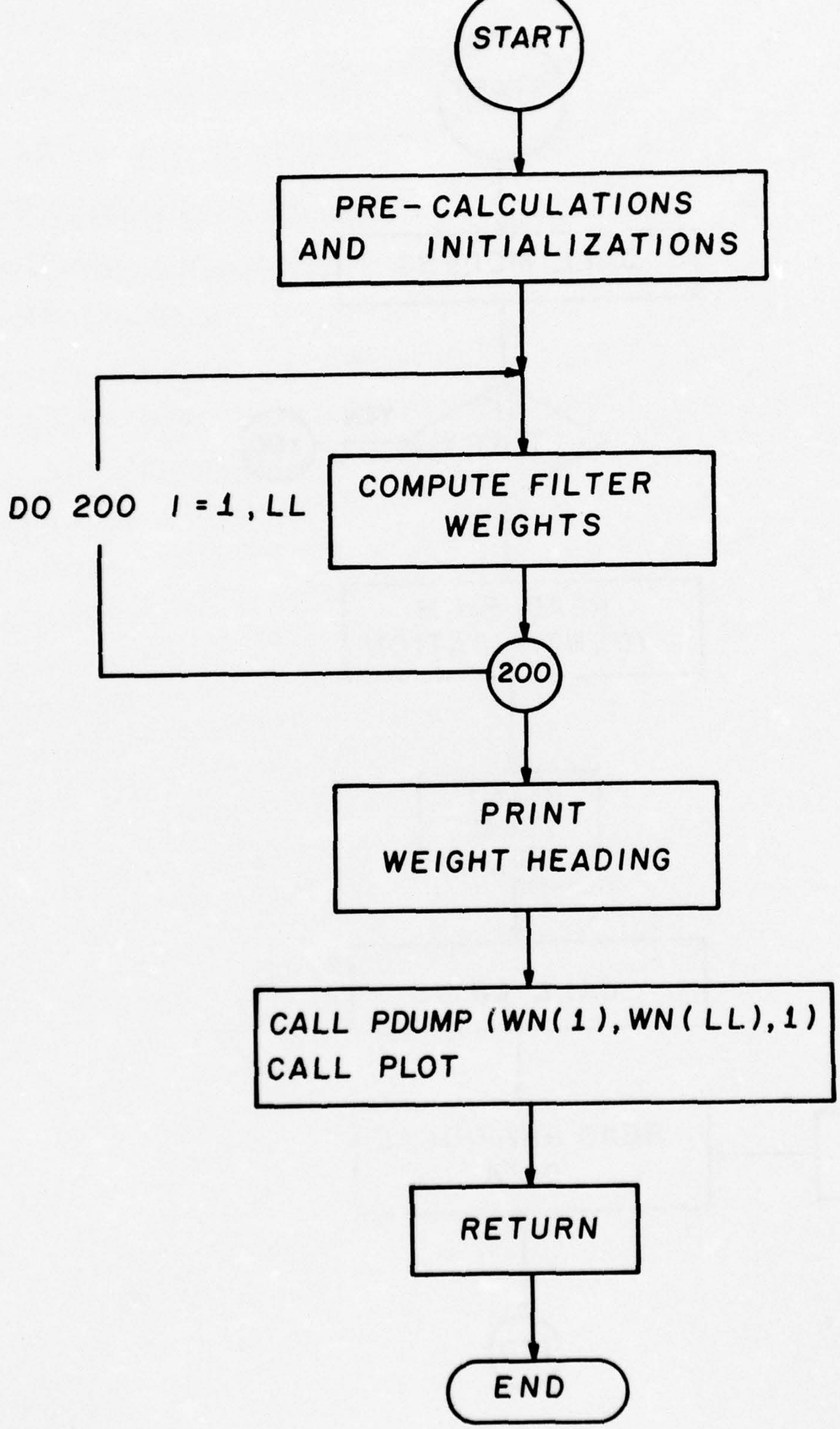
STATCOM


B
IF
IIC.EQ.2
YES
450
PRINT MAXIMUM,
AVERAGE, AND
STANDARD DEVIATION
OF GEOID HEIGHT
RESIDUALS
M = 1
CALL PLOT FOR GEOID
HEIGHT RESIDUALS
RETURN

STATCOM

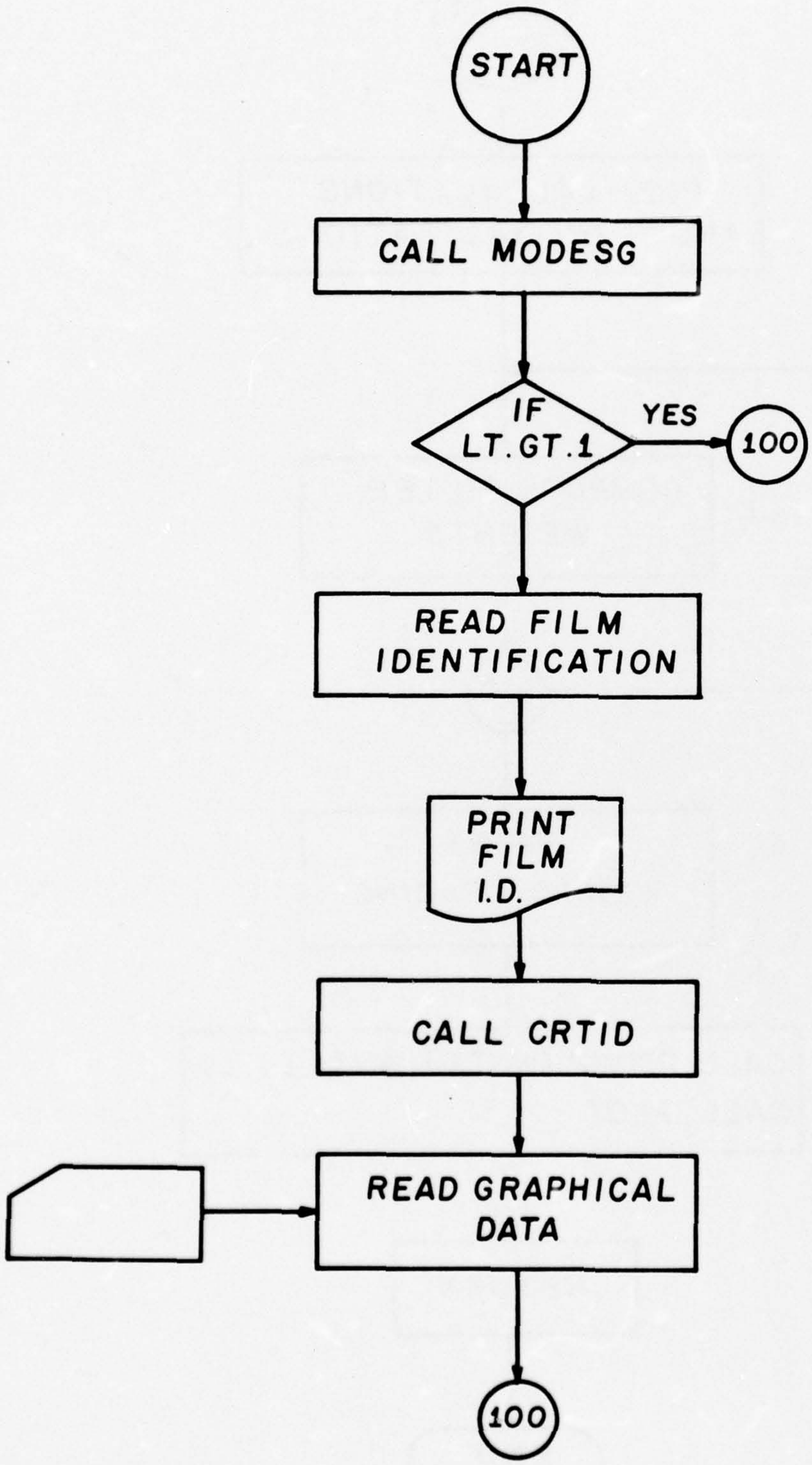

450
PRINT
MAXIMUM, AVERAGE,
AND STANDARD DEVIATION
OF VERTICAL DEFLECTION
RESIDUALS
M = 1
CALL PLOT FOR
VERTICAL DEFLECTION
RESIDUALS
RETURN
END

DVCMPS

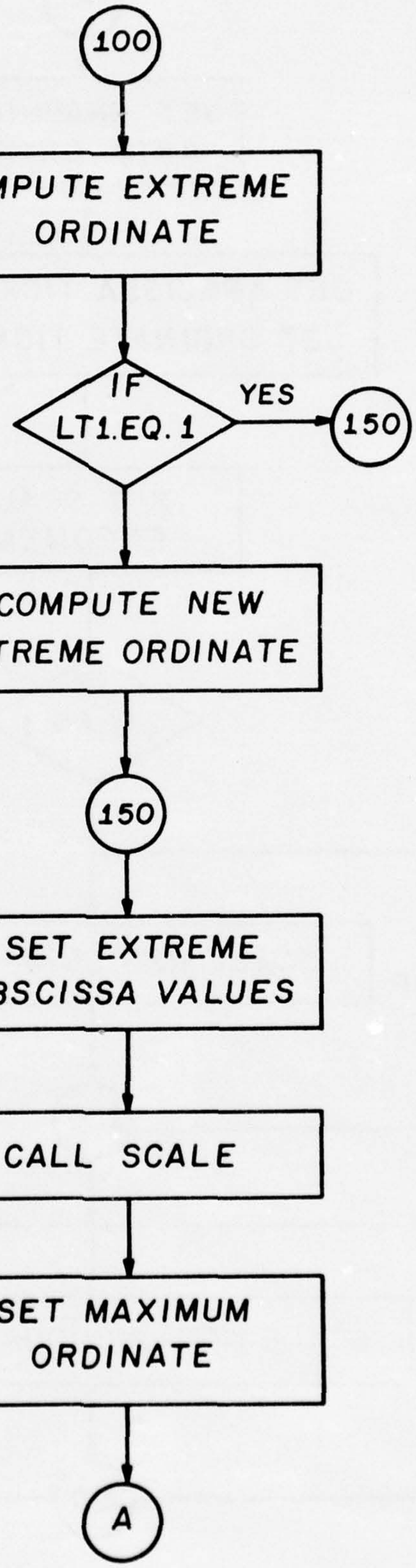


START
PRE- CALCULATIONS AND INITIALIZATIONS
DO 200 I = 1, LL
COMPUTE FILTER WEIGHTS
200
PRINT WEIGHT HEADING
CALL PDUMP (WN(1), WN(LL), 1)
CALL PLOT
RETURN
END

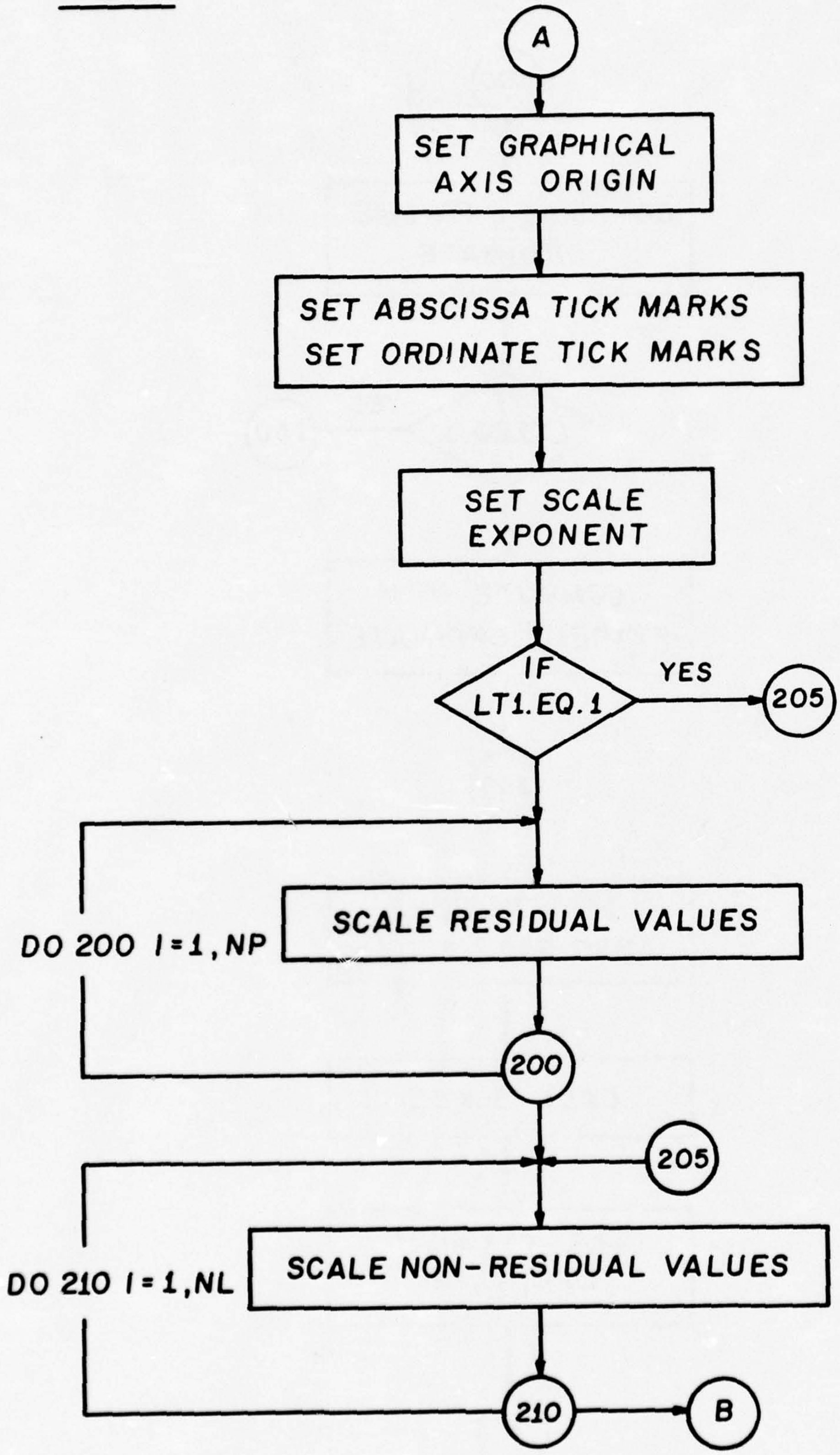
PLOT


START
CALL MODESG
IF
LT.GT.1
YES
100
READ FILM
IDENTIFICATION
PRINT
FILM
I.D.
CALL CRTID
READ GRAPHICAL
DATA
100

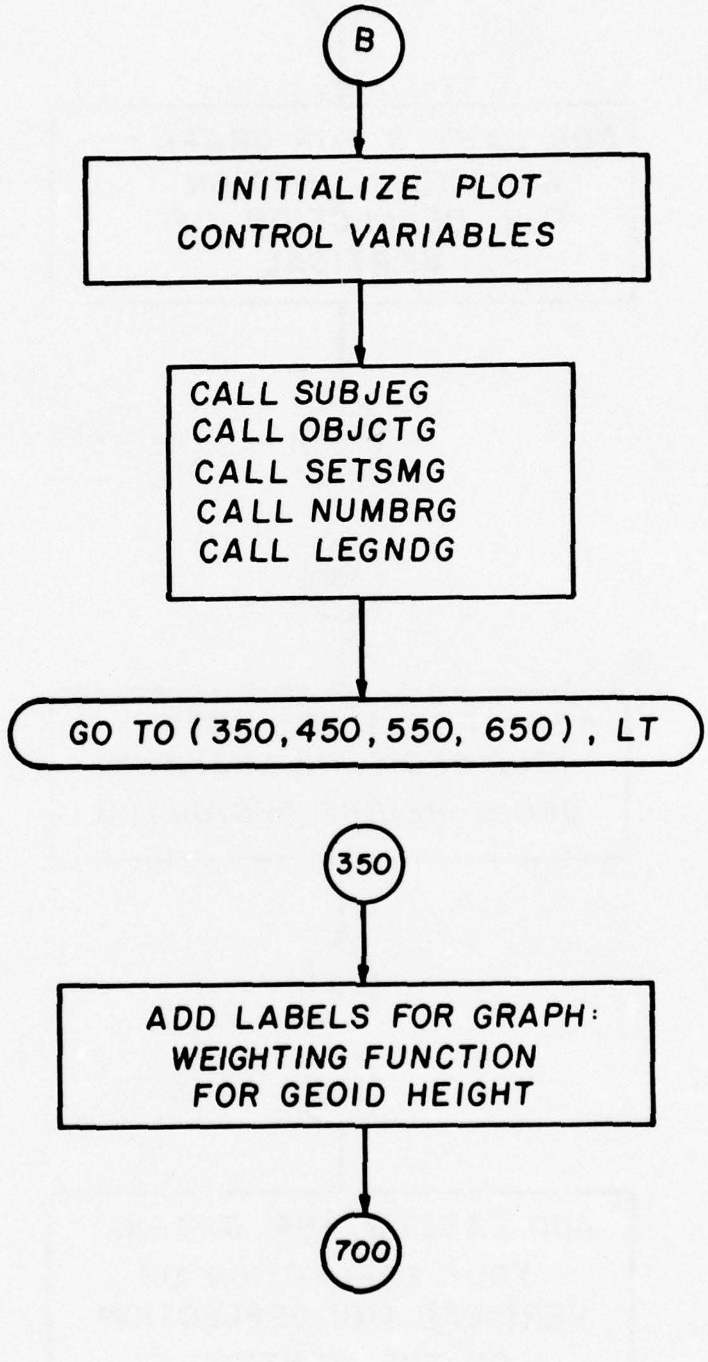
PLOT


100
COMPUTE EXTREME ORDINATE
IF LT1.EQ.1
YES
150
COMPUTE NEW EXTREME ORDINATE
150
SET EXTREME ABSCISSA VALUES
CALL SCALE
SET MAXIMUM ORDINATE
A

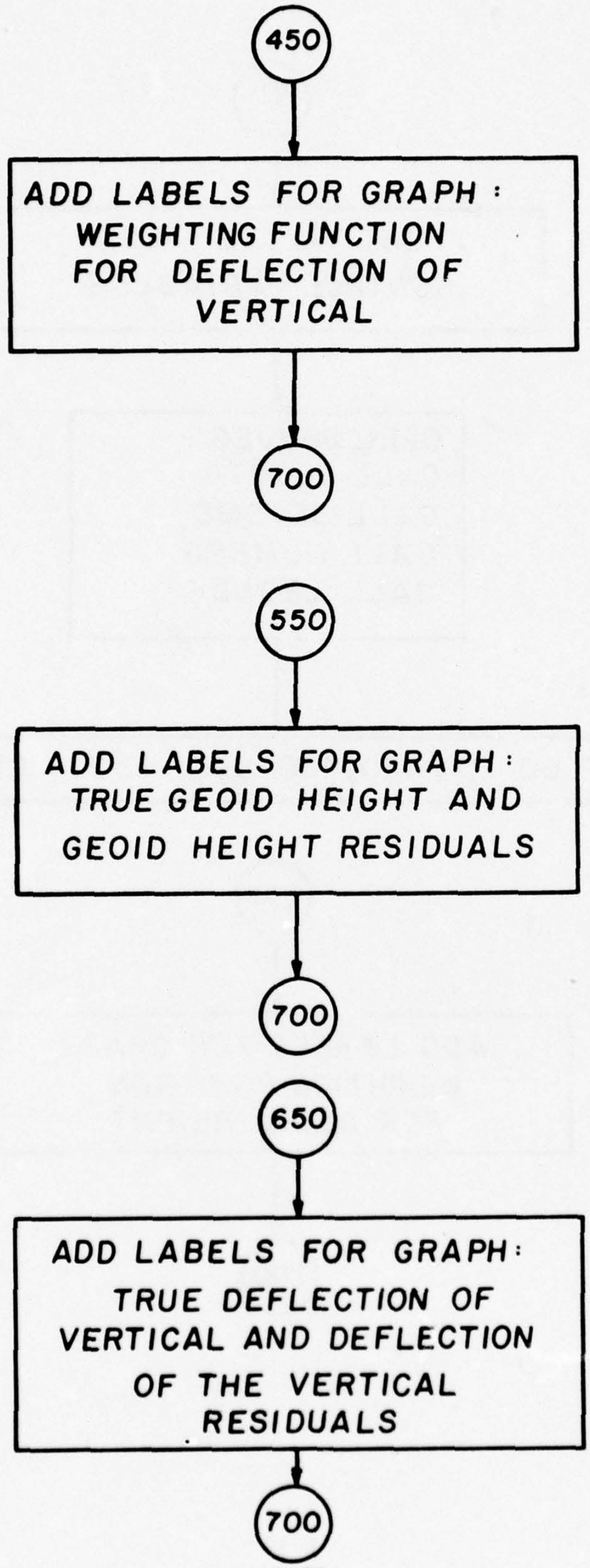
PLOT


A
SET GRAPHICAL AXIS ORIGIN
SET ABSCISSA TICK MARKS
SET ORDINATE TICK MARKS
SET SCALE EXPONENT
IF LT1.EQ.1
YES
205
DO 200 I=1,NP
SCALE RESIDUAL VALUES
200
205
DO 210 I=1,NL
SCALE NON-RESIDUAL VALUES
210
B

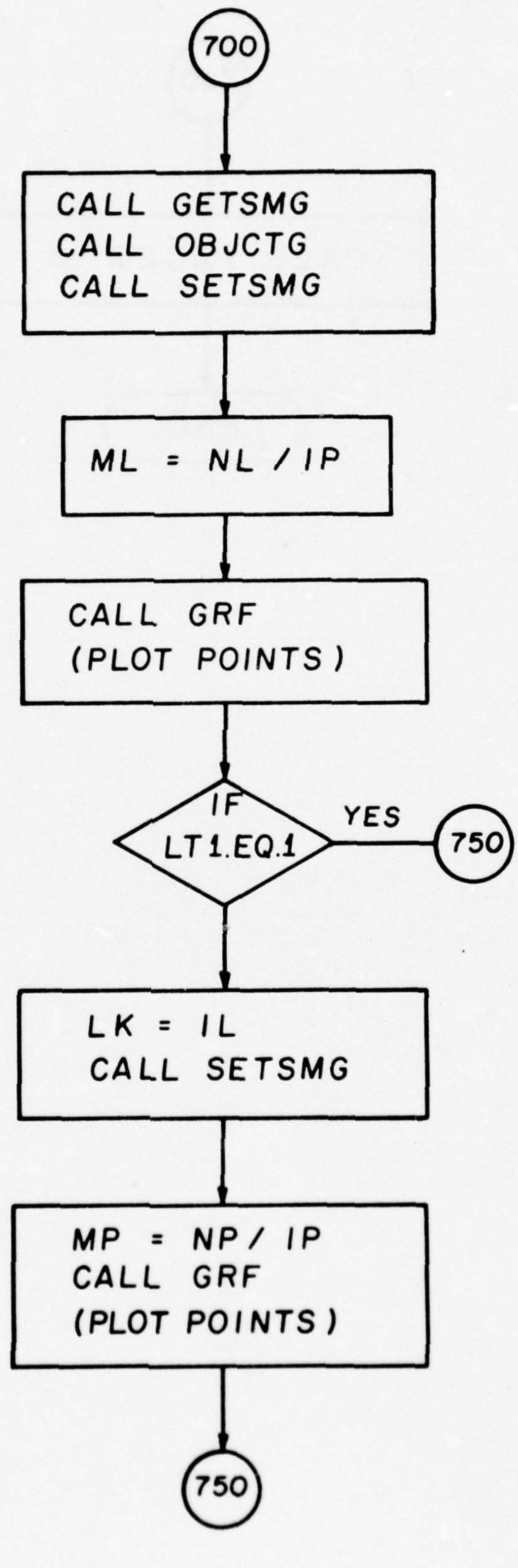
PLOT


B
INITIALIZE PLOT CONTROL VARIABLES
CALL SUBJEG
CALL OBJCTG
CALL SETSMG
CALL NUMBRG
CALL LEGNDG
GO TO (350,450,550, 650), LT
350
ADD LABELS FOR GRAPH: WEIGHTING FUNCTION FOR GEOID HEIGHT
700

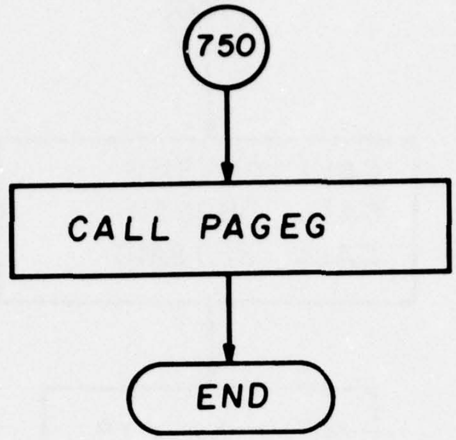
PLOT


450
ADD LABELS FOR GRAPH: WEIGHTING FUNCTION FOR DEFLECTION OF VERTICAL
700
550
ADD LABELS FOR GRAPH: TRUE GEOID HEIGHT AND GEOID HEIGHT RESIDUALS
700
650
ADD LABELS FOR GRAPH: TRUE DEFLECTION OF VERTICAL AND DEFLECTION OF THE VERTICAL RESIDUALS
700

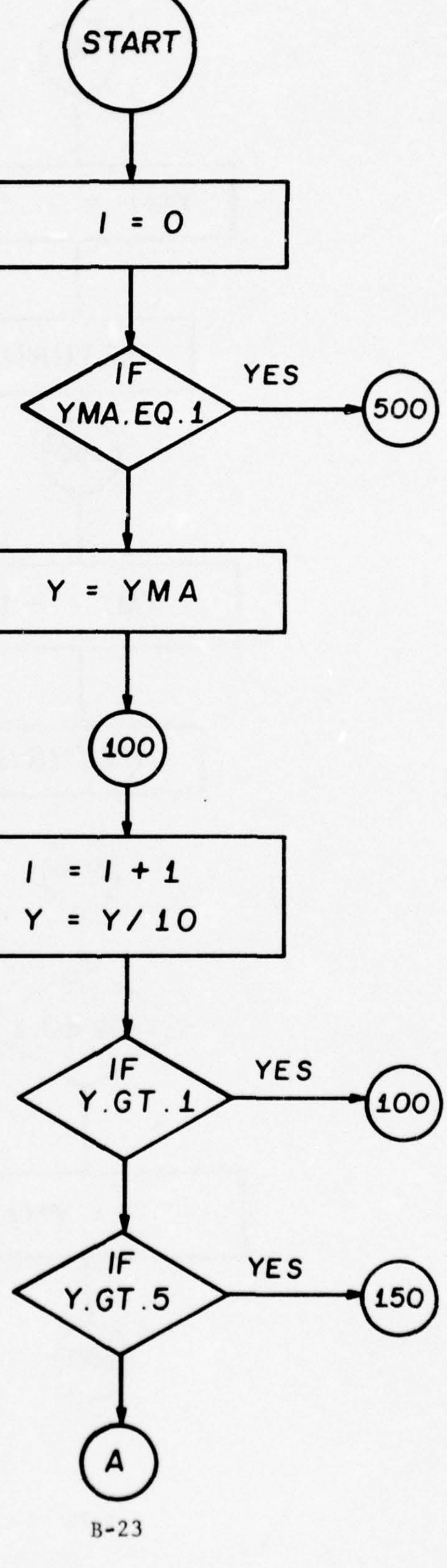
PLOT


700
CALL GETSMG
CALL OBJCTG
CALL SETSMG
ML = NL / IP
CALL GRF
(PLOT POINTS)
IF
LT1.EQ.1
YES
750
LK = IL
CALL SETSMG
MP = NP/ IP
CALL GRF
(PLOT POINTS)
750

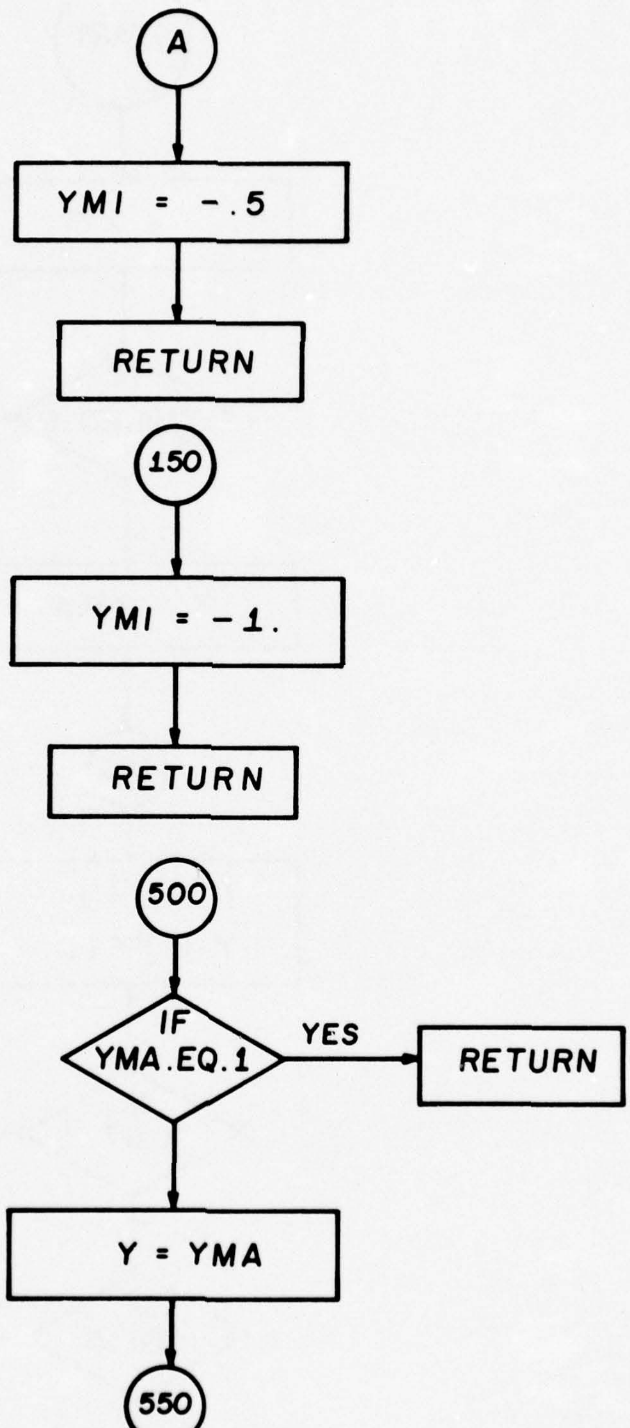
PLOT



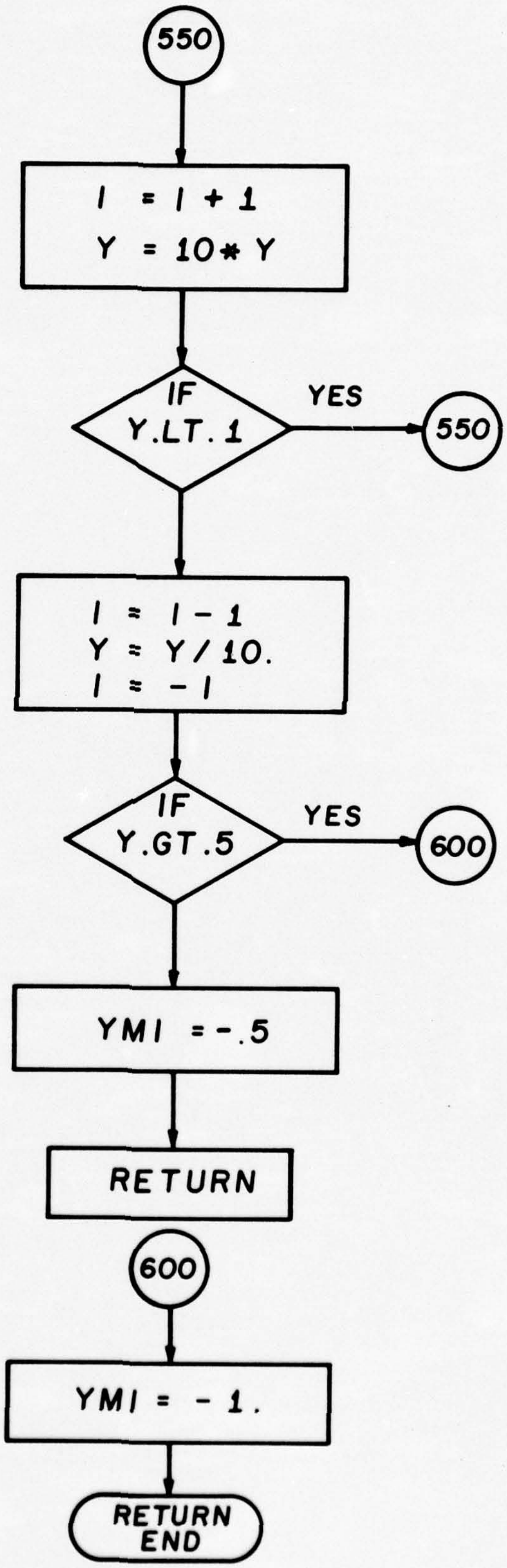
SCALE


START
I = 0
IF
YMA.EQ.1
YES
500
Y = YMA
100
I = I + 1
Y = Y/10
IF
Y.GT.1
YES
100
IF
Y.GT.5
YES
150
A

SCALE


A
YMI = -.5
RETURN
150
YMI = -1.
RETURN
500
IF
YMA.EQ.1
YES
RETURN
Y = YMA
550

SCALE


550
I = I + 1
Y = 10* Y
IF
Y.LT. 1
YES
550
I = I - 1
Y = Y / 10.
I = - I
IF
Y.GT.5
YES
600
YMI = -.5
RETURN
600
YMI = - 1.
RETURN
END

Appendix C

Program Extended Fortran IV Listing

RADAP PROGRAM

```
*DECK RADAP
      PROGRAM RADAP(INPUT,OUTPUT,TAPE1,TAPE10,TAPE51=OUTPUT,TAPE2)
      COMMON/ARRAY/ X(6300),Y(6300),YN(6300),D(6300),WN(6300),
     1YNT(6300)
C *** CARD INPUT ***
      COMMON/LCIN/ BRDC, SDD, SDV, FDS, LSX,LFSP
      COMMON/VAR / NR,DATE,        NGS , SN , N
     1,IL,NP,LL
      COMMON/LOC/L ,NFS
      COMMON/NAME/H(2),Z(200)
      DIMENSION B(3)
      PRINT 1000
      PRINT 1010
      PRINT 1020
C *** INPUT CARD DATA ***
C     *** IT=2 OR 3 (TYPE GEOICAL FEATURE) ***
      READ  1030, BRDC ,SDD,NFS ,LSX,IC
      PRINT 1035, BRDC ,SDD,NFS ,LSX,IC
      READ  1040,  SDV ,FDS,LFSP
      PRINT 1045,  SDV ,FDS,LFSP
      LFS     =2 * LFSP + 1
      L       =LFSP
      IGF     =1
      IT      =2
      REWIND 1
      READ  (1) NFS
      REWIND 1
      REWIND 2
      IF (NFS.EQ.1)  IT =3
      IF(IT.EQ.2) GO TO 200
      READ  (1) NFS,NR,DATE,(B(I),I=IGF,IT),NGS,SN,N
      PRINT 1050
      PRINT 1055,NFS,NR,DATE,(B(I),I=IGF,IT),NGS,SN,N
      IF (IC.EQ.0) GO TO 250
      PRINT 1070
C     *** TAPE2-HEADER 1 ***
      WRITE (2) NFS,NR,DATE,(B(I),I=IGF,IT),NGS,SN,N
      PRINT 1055,NFS,NR,DATE,(B(I),I=IGF,IT),NGS,SN,N
C     *** TAPE2-HEADER 2 ***
      II      = N - 2 * LFSP
      WRITE (2) NFS,BRDC,SDD,LSX,SDV,FDS,LFS,II
      PRINT 1075 , NFS,BRDC,SDD,LSX,SDV,FDS,LFS,II
      GO TO 250
  200 READ  (1) NFS,NR,DATE,(B(I),I=IGF,IT),NGS,SN,N
      PRINT 1050
```

```
      PRINT 1060,NFS,NR,DATE,(B(I),I=IGF,IT),NGS,SN,N
      IF (IC.EQ.0) GO TO 250
      PRINT 1070
C     *** TAPE2-HEADER 1 ***
      WRITE (2) NFS,NR,DATE,(B(I),I=IGF,IT),NGS,SN,N
      PRINT 1060,NFS,NR,DATE,(B(I),I=IGF,IT),NGS,SN,N
C     *** TAPE2-HEADER 2 ***
      II      = N - 2 * LFSP
      WRITE (2) NFS,BRDC,SDD,LSX,SDV,FDS,LFS,II
      PRINT 1075 , NFS,BRDC,SDD,LSX,SDV,FDS,LFS,II
  250 CALL TLIST (X , Y , YN , D ,N)
      CALL GHCMPTS
      CALL CMPSGH (WN,YNT,NP,YN,1)
      CALL STATCOM (1, IC)
      CALL DVCMPS
      CALL CMPSGH (WN,YNT,NP,YN,2)
      CALL STATCOM (2, IC)
      REWIND 2
      CALL CRTID (Z,H)
      CALL EXITG (Z)
 1000 FORMAT(1H ,*RADAR ALTIMETER DATA ANALYSIS PROGRAM (RADAP) ,VERSION
     1-2,11/14/72*,/)
 1010 FORMAT(1H1,41X,*RADAR ALTIMETER DATA ANALYSIS PROGRAM*,//)
 1020 FORMAT(1H ,*INPUT CARD DATA*,//)
 1030 FORMAT(2E25.14,3I5)
 1035 FORMAT(1H ,*BRDC = *,E25.14,* ( /KM) - INVERSE CORRELATION DISTANC
     1E*,/1H ,
     1*SDD = *,E25.14,*(METERS) - SINGLE PULSE RADAR SIGMA*,/1H ,
     2*NFS = *,I5,* FUNCTION OF VERTICAL*,/1H ,
     2*LSX = *,I5,* FILTER FIT / DATA SPACING*,/1H ,
     4* IC = *,I5,*(0= NC FILE , 1= OUTPUT FILE)*,/)
 1040 FORMAT(2E25.14,I10)
 1045 FORMAT(1H ,*SDV = *,E25.14,* (ARCSEC) - SIGMA DEFLECTION*,/1H ,
     1*FDS = *,E25.14,* (KMETERS) - DATA SPACING*,/1H ,
     2* LFSP = *,I10,* 1/2 (NUMBER OF FILTER FIT POINTS)*,/)
 1050 FORMAT(1H ,*TAPE INPUT*,//)
 1055 FORMAT(1H ,2I5,4A10,I5,E22.14,I5,//)
 1060 FORMAT(1H ,2I5,3A10,I5,E22.14,I5,//)
 1070 FORMAT(1H ,*TAPE 2 OUTPUT HEADER RECORDS*,//)
 1075 FORMAT (1H ,I5,2E25.14,I5,2E25.14,2I5,//)
      END
```

```
*DECK TLIST
      SUBROUTINE TLIST (X , Y , YN , D , N)
      DIMENSION X(N),Y(N),YN(N),D(N)
      READ  (1) X , YN
      READ  (1) Y , D
      REWIND 1
      RETURN
      END
```

```
*DECK GHCMPTS
      SUBROUTINE GHCMPTS
      COMMON/ARRAY/ X(6300),Y(6300),YN(6300),D(6300),WN(6300),
     1YNT(6300)
C *** CARD INPUT ***
      COMMON/LOIN/ BRDC, SDD, SDV, FDS, LSX,LFSP
C *** TAPE INPUT ***
      COMMON/VAR / NR,DATE,          NGS , SN , N
     1,IL,NP,LL
      COMMON/LOC/L ,NFS
C     *** COMPUTE FILTER WEIGHTS ***
      ID      =L * LSX
      LM      =(N-1) / 2
      IL      =LM - ID + 1
      SR3     =1.732050808
      SDV     = 4.848136811 E-06 * SDV
      SDVS    = SDV * SDV
      SDD     = 1.E-03 * SDD
      SDDS    = SDD * SDD
      BRDCS   = BRDC* BRDC
      BRDCQ   = BRDC* BRDCS
      RNR     =  16.* SDVS
      DR      = SDDS * FDS * BRDCQ
      R       = RNR / DR
      R       = ABS (R)
      R       =       ALOG (R) / 3.
      R       = EXP (R)
      RS      = R * R
      RM2     = R - 2.
      SRA     = 1 - R + RS
      SRA     =SQRT (SRA)
      RRR     = 2 * SRA
      AR      =1. + R
      SRB     = SQRT (AR)
      R1A     = RRR + RM2
      R1      =  SQRT (R1A) * .5
      R1A     = RRR - RM2
      R2      =  SQRT (R1A) * .5
      R6      =  R / 6.
      LL      = 2 * LFSP + 1
      NP      =LL
      J       =- LFSP - 1
      DO  200    I  = 1, LL
      J = J + 1
      FDS1    =J * FDS
      SJ      = ABS ( FDS1)
      RJ      = BRDC * SJ
      R1RJ    = R1 * RJ
      R2RJ    =(-R2)* RJ
      SRB1    = - SRB * RJ
```

```
      F        = R6 *((R1*(SIN (R1RJ) + SR3 *(COS (R1RJ))) +
     1                  R2*( SR3*SIN(R1RJ)-    (COS (R1RJ))))* EXP(R2RJ) /
     2                  SRA +  EXP (SRB1)      / SRB)
      WN (I) = BRDC * F
  200 CONTINUE
      PRINT 400
      CALL PDUMP (WN(1),WN(LL),1)
      CALL PLOT ( WN , X ,LL, 1, 1  , NFS,IL)
  400 FORMAT (1H ,*GEOID HEIGHT WEIGHT*,//)
      RETURN
      END
```

```
*DECK CMPSGH
      SUBROUTINE CMPSGH (WN,YNT,NP,YN,IC)
C *** CARD INPUT ***
      COMMON/LCIN/ BRDC, SDD, SDV, FOS, LSX,LFSP
      COMMON/VAR / NR,DATE,       NGS , SN , N
     1,IL,NZ,LL
      COMMON/LOC/L ,NFS
      DIMENSION YNT(6300),WN(NP), YN(6300)
      IL      = (NP - 1) / 2. + 1
      NPT     =N - 2. * (IL - 1)
      NT      = IL + NPT - 1
      NZ      =NPT
      J       =0
       DO   210  I  = IL ,NT
      J       = J +1
       YNN    = 0.
       DO   200  K  = 1,LL
      IA      = J + (K - 1) * LSX
      YNN             =YNN + WN(K) * YN(IA)
  200 CONTINUE
       YNT (J )      = FDS * YNN
  210 CONTINUE
      IF (IC.EQ.2) GO TO 400
      PRINT 300
  300 FORMAT (1H ,*GEOID HEIGHT ESTIMATES*,//)
      GO TO 500
  400 PRINT 350
  350 FORMAT (1H ,*VERTICAL DEFLECTION ESTIMATES*,//)
  500 CALL PDUMP(YNT(1),YNT(NP),1)
      RETURN
      END
```

```
*DECK STATCOM
      SUBROUTINE STATCOM (IC,IIC)
      COMMON/ARRAY/ X(6300),Y(6300),YN(6300),D(6300),WN(6300),
     1YNT(6300)
      COMMON/LCIN/ BRDC, SDD, SDV, FDS, LSX,LFSP
      COMMON/VAR / NR,DATE,       NGS , SN , N
     1,IL,NP,LL
      COMMON/LOC/L ,NFS
C     *** COMPUTE RESIDUALS OF EST AND TRUE VALUES ***
      IF (IC.EQ.2) GO TO 150
      DO 100  I     = 1, NP
      WN (I) = YNT (I) - Y (I + IL)
  100 CONTINUE
      IF (IIC.EQ.0) GO TC 300
      WRITE (2) NP,(WN(I),I = 1,NP)
      GO TO 300
  150 DO 200  I     = 1, NP
      WN (I) = YNT (I) - D (I + IL)
  200 CONTINUE
      IF (IIC.EQ.0) GO TO 300
      WRITE (2) NP,(WN(I),I = 1,NP)
  300  AXDS1 = AMAXE (WN , NP)
       AXDS2 = AMINE (WN , NP)
       AX1   = ABS ( AXDS1)
       AX2   = ABS ( AXDS2)
       AXDS1 = AMAX1 ( AX1 ,   AX2)
C     *** COMPUTE AVE VALUE OF RESIDUALS ***
      AVE    = 0.
      DO  350  I    = 1, NP
      AVE    = AVE   + WN(I)
  350 CONTINUE
      AVE    = AVE / NP
C     *** COMPUTE STANDARD DEVIATION OF RESIDUAL
      SIGMA  = 0.
      DO  400  I    = 1, NP
      SS     = WN (I)  - AVE
      SS     = SS * SS
      SIGMA  = SIGMA + SS
  400 CONTINUE
      SIGMA  = SIGMA / NP
      SIGMA  = SQRT (SIGMA)
      IF (IC.EQ.2) GO TO 450
      PRINT 1000,  AXDS1
      PRINT 1005,  AVE
      PRINT 1010,  SIGMA
      M      = 1
      CALL PLOT ( Y  , X , N, 3, 2  , NFS,M)
      RETURN
  450 PRINT 1015 , AXDS1
      PRINT 1020 ,AVE
```

```
      PRINT 1025 ,SIGMA
      M       = 1
      CALL PLOT ( D   , X , N, 4, 2   , NFS,M)
 1000 FORMAT(1H ,*MAXIMUM GEOID HEIGHT RESIDUAL = *, F6.2,* METERS*,/)
 1005 FORMAT(1H ,*AVERAGE GEOID HEIGHT RESIDUAL = *, F6.2,* METERS*,/)
 1010 FORMAT(1H ,*SIGMA OF GEOID HEIGHT ESTIMATE = *,F6.2,* METERS*,/)
 1015 FORMAT(1H ,*MAXIMUM VERTICAL DEFLECTION RESIDUAL = *,F6.2,* ARCSEC
     1*,/)
 1020 FORMAT(1H ,*AVERAGE VERTICAL DEFLECTION RESIDUAL = *
 10201,F6.2,* ARCSEC*,/)
 1025 FORMAT(1H ,*SIGMA OF VERTICAL DEFLECTION ESTIMATE = *
 10251,F6.2,* ARCSEC*,/)
      RETURN
      END
```

```
*DECK DVCMPS
      SUBROUTINE DVCMPS
      COMMON/ARRAY/ X(6300),Y(6300),YN(6300),D(6300),WN(6300),
     1YNT(6300)
C *** CARD INPUT ***
      COMMON/LCIN/ BRDC, SDD, SDV, FDS, LSX,LFSP
C *** TAPE INPUT ***
      COMMON/VAR / NR,DATE,        NGS , SN , N
     1,IL,NP,LL
      COMMON/LOC/L ,NFS
C     *** COMPUTE FILTER WEIGHTS ***
      ID      =L * LSX
      LM      = (N - 1) / 2
      IL      =LM - ID + 1
      SR3     =1.732050808
      SDVS    = SDV * SDV
      SDDS    = SDD * SDD
      BRDCS   = BRDC* BRDC
      BRDCQ   = BRDC* BRDCS
      RNR     =  16.* SDVS
      DR      = SDDS * FDS * BRDCQ
      R       = RNR / DR
      R       = ABS (R)
      R = (ALOG(R))/3.
      R       = EXP (R)
      RS      = R * R
      RM2     = R - 2.
      SRA     = 1 - R + RS
      RRR     = 2 * SQRT (SRA)
      AR      =1. + R
      SRB     = SQRT (AR)
      R1A     = RRR + RM2
      R1      =  SQRT (R1A) * .5
      R1A     = RRR - RM2
      R2      =  SQRT (R1A) * .5
      R6      =  R / 6.
      LL      = 2 * LFSP + 1
      NP      =LL
      J       =- LFSP - 1
C     CALL PDUMP(RNR,RNR,1,R,R,1,R1,R1,1,R2,R2,1)
      DO  200   I  = 1, LL
      J = J + 1
      FDS1    =J * FDS
      SJ      = ABS ( FDS1)
      RJ      = BRDC * SJ
      R1RJ    = R1 * RJ
      R2RJ    =(-R2)* RJ
      SRBE    =-SRB * RJ
      F       = R6 *   ((    COS(R1RJ) - SR3 * SIN (R1RJ))  * EXP (R2RJ)
     1 - EXP (SRBE))
```

```
      IF (FDS1.EQ.0.) GO TO 190
      WN (I) = BRDCS * F*FDS1 / SJ
      GO TO 200
190   WN (I) = BRDCS * F
200   CONTINUE
      PRINT 400
400   FORMAT (1H ,*VERTICAL DEFLECTION WEIGHTS*,//)
      CALL PDUMP(WN(1),WN(NP),1,IL,IL,2)
      CALL PLOT ( WN , X ,LL, 2, 1  , NFS,IL)
      DO 300 I = 1,LL
      WN(I)   = 206.2648062 * WN(I)
300   CONTINUE
      RETURN
      END
```

```
*DECK PLOT
      SUBROUTINE PLOT (ZN,X   ,NL , LT,LT1,NFS,LK)
      COMMON/LOIN/ BRDC, SDD, SDN, FDS, LSX,LFSP
      COMMON/VAR / NR,DATE,        NGS , SN , N
     1,IL,NP,LL
      COMMON/NAME/ H ,Z
      COMMON/ARRAY/ DUM(25200),WN(6300),DUM1(6300)
      DIMENSIONZN(6300),X(NL),ZW(6300)
      DIMENSION H(2) ,Z(200)
      DIMENSION DA(3), TN(3)
      DATA XLO,YLO,XHI,YHI /.03,.06,1.14, .94/
      DATA X10/3HX10/
C     *** LT = GRAPH NO.
C     *** LT1 = 1 OR 2 PLOTS / GRAPH
      CALL MODESG (Z,0)
      IF (LT.GT.1) GO TO 100
      READ  1000 , H
      PRINT 1005,H
      CALL CRTID (Z,H)
      READ 1010, DA,TN,IP
      PRINT 1015 ,DA,TN,IP
  100 LTT     =NL
      YMI     = AMINE (ZN, LTT )
      YMX     = AMAXE (ZN, LTT )
      YM1     = ABS (YMI)
      YM2     = ABS (YMX)
      YMI     =    AMAX1 (YM1,YM2)
      YMA     =YMI
      IF(LT1.EQ.1) GO TO 150
      YM1     = AMINE (WN,NP)
      YMX     = AMAXE (WN,NP)
      YM1     = ABS (YM1)
      YM2     = ABS (YMX)
      YM1     = AMAX1 (YM1,YM2)
      YMA     = AMAX1 (YM1,YMI)
  150 XMIN    =X(LK)
      XMA     = -XMIN
      CALL SCALE (YMA ,KE,YMI )
      YMA     =-YMI
      XOR     = XMIN
      YOR     = 0.
      DX      = 2 * XMA / 10.
      DY      =YMA/5.
      R       =-KE
      IF(LT1.EQ.1) GO TO 205
      DO  200  I   =1,NP
      WN (I) = WN(I) * 10.** R
  200 CONTINUE
  205 DO 210  I    =1,NL
      ZW (I) = ZN (I) * 10.**R
```

```
210 CONTINUE
    IT      = -1
    LA      =IP
    LO      =IP
    M       =  0
300 CALL SUBJEG (Z,0.,C.,4095.,3071.)
    CALL OBJCTG (Z,XLO, YLO,XHI, YHI )
    CALL SETSMG (Z, 45,.75)
    CALL SETSMG (Z,113,XLO)
    CALL SETSMG (Z,114,YLO)
    CALL SETSMG (Z,115,XHI)
    CALL SETSMG (Z,116,YHI)
    CALL NUMBRG (Z,0248.,2530.,3 ,KE)
    CALL LEGNDG (Z,0186.,2479.,3 ,3HX10)
    GO TO (350,450,550,650) ,LT
350 CALL LEGNDG (Z,1561.,2734., 35,35HWEIGHTING FUNCTION FOR GEOID HEI
   1GHT)
    CALL LEGNDG (Z,1561.,2683.,  9, 9HRUN NO.  )
    CALL NUMBRG (Z,1840.,2683.,  5, NR          )
    CALL LEGNDG (Z,2150.,2683.,  6, 6HDATE   )
    CALL NUMBRG (Z,2460.,2683.,-10, DATE     )
    CALL LEGNDG (Z,1561.,2632., 15,15HDATA/NOISE TYPE)
    CALL LEGNDG (Z,1933.,2632., 30,    DA)
    CALL LEGNDG (Z,2526.,2632.,  3, 3H / )
    CALL LEGNDG (Z,1933.,2581., 30,    TN)
    CALL TITLEG(Z,0,XC,14,14HFILTER WEIGHTS,0,TC)
    CALL TITLEG(Z,23,23HALONG TRACK DISTANCE-KM, 0,YC,0 ,TC)
    GO TO 700
450 CALL LEGNDG (Z,1561.,2734., 45, 45HWEIGHTING FUNCTION FOR DEFLECTI
   1ON OF VERTICAL)
    CALL LEGNDG (Z,1561.,2683.,  9,  9HRUN NO.  )
    CALL NUMBRG (Z,1840.,2683.,  5,  NR         )
    CALL LEGNDG (Z,2150.,2683.,  6,  6HDATE   )
    CALL NUMBRG (Z,2460.,2683.,-10,  DATE     )
    CALL LEGNDG (Z,1561.,2632., 15,15HDATA/NOISE TYPE)
    CALL LEGNDG (Z,1933.,2632., 30,    DA)
    CALL LEGNDG (Z,2526.,2632.,  3,  3H / )
    CALL LEGNDG (Z,1933.,2581., 30,    TN)
    CALL TITLEG(Z,0,XC,14,14HFILTER WEIGHTS,0,TC)
    CALL TITLEG(Z,23,23HALONG TRACK DISTANCE-KM, 0,YC,0 ,TC)
    GO TO 700
550 CALL LEGNDG(Z,1561.,2734.,21,21HTRUE GEOID HEIGHT AND)
    CALL LEGNDG(Z,1561.,2683.,22,22HGEOID HEIGHT RESISUALS)
    CALL LEGNDG (Z,1561.,2632.,  9,  9HRUN NO.  )
    CALL NUMBRG (Z,1840.,2632.,  5,  NR         )
    CALL LEGNDG (Z,2150.,2632.,  6,  6HDATE   )
    CALL NUMBRG (Z,2460.,2632.,-10,  DATE     )
    CALL LEGNDG (Z,1561.,2581., 15,15HDATA/NOISE TYPE)
    CALL LEGNDG (Z,1933.,2581., 30,    DA)
    CALL LEGNDG (Z,2526.,2581.,  3,  3H / )
```

```
      CALL LEGNDG (Z,1933.,2531., 30,    TN)
      CALL TITLEG(Z,0,XC,19,19HGEOID HEIGHT-METERS,0,TC)
      CALL TITLEG(Z,23,23HALONG TRACK DISTANCE-KM, 0,YC,0 ,TC)
      GO TO 700
  650 CALL LEGNDG (Z,1561.,2734.,31,31HTRUE DEFLECTION OF VERTICAL AND)
      CALL LEGNDG (Z,1561.,2683.,36,36HDEFLECTION OF THE VERTICAL RESIDU
     1ALS)
      CALL LEGNDG (Z,1561.,2632.,  9,  9HRUN NO.  )
      CALL NUMBRG (Z,1840.,2632.,  5,  NR          )
      CALL LEGNDG (Z,2150.,2632.,  6,  6HDATE  )
      CALL NUMBRG (Z,2460.,2632.,-10,  DATE      )
      CALL LEGNDG (Z,1561.,2581., 15,15HDATA/NOISE TYPE)
      CALL LEGNDG (Z,1933.,2581., 30,     DA)
      CALL LEGNDG (Z,2526.,2581.,  3,  3H / )
      CALL LEGNDG (Z,1933.,2531., 30,     TN)
      CALL TITLEG(Z,0,XC,29,29HDEFLECTION OF VERTICAL-ARCSEC,0,TC)
      CALL TITLEG(Z,23,23HALONG TRACK DISTANCE-KM, 0,YC,0 ,TC)
  700 CALL GETSMG (Z,40,Z40)
      CALL GETSMG (Z,41,Z41)
      CALL OBJCTG(Z,XLO +2.*Z40-2.*Z40,
     1YLO+2.*Z41,XHI-2.*Z40,YHI-10.*Z41)
      CALL SETSMG(Z,55,0.)
C     CALL PDUMP(XMIN,XMIN,1,YMI,YMI,1,XMA,XMA,1,YMA,YMA,1,XOR,XOR,1,YOR
C    1,YOR,1,DX,DX,1,DY,DY,1,NL,NL,2,X(LK),X(NL),1,ZW(1),ZW(NL),1)
      ML      =NL/IP
      CALL GRF(XMIN, YMI  ,XMA,YMA,XOR,YOR,DX,DY,
     10,2,0,ML, X(LK) , ZW (1), LA  , LO , 1H*  ,
     2IT , M   ,0., 0 , 0. ,XL1 , 1. , 4 , 0, Z)
      IF(LT1.EQ.1) GO TO 750
      LK      =IL
      CALL SETSMG(Z,55,0.)
C     CALL PDUMP(IL,IL,2,KE,KE,2,YMA,YMA,1)
C     CALL PDUMP(NP,NP,2,WN(1),WN(NP),1)
      MP      =NP/IP
      CALL GRF(XMIN, YMI  ,XMA,YMA,XOR,YOR,DX,DY,
     10,2,1,MP, X(LK) , WN (1), LA  , LO , 1H+  ,
     2IT , M   ,0., 0 , 0. ,XL1 , 1. , 4 , 0, Z)
  750 CONTINUE
      CALL PAGEG(Z,0,0,1)
 1000 FORMAT (2A10)
 1005 FORMAT(1H ,*FILM IDENTIFICATION = *,2A10)
 1010 FORMAT    (3A10,3A10,I5)
 1015 FORMAT(1H ,*DA = *,3A10,*TN = *,3A10,*IP = *,I5)
      RETURN
      END
```

```
*DECK SCALE
      SUBROUTINE SCALE (YMA,I ,YMI )
C     *** YMA GT 1 ***
      I       = 0
      IF (YMA.LE.1.)  GO TO 500
      Y       = YMA
  100 I       = I + 1
      Y       = Y   / 10
      IF (Y.GT.1.) GO TO 100
C     *** YMA IN FRACTION FORM .YMA X 10 ** I)
      IF (Y.GT..5) GO TO 150
      YMI     = -.5
      RETURN
  150 YMI     =-1.
      RETURN
  500 IF (YMA.EQ.1.)RETURN
      Y       = YMA
  550 I       = I +1
      Y       = 10 * Y
      IF (Y.LT. 1.) GO TO 550
      I       = I - 1
      Y       = Y   / 10.
      I       = -I
      IF (Y.GT..5) GO TO 600
      YMI     = -.5
      RETURN
  600 YMI     =-1.
      RETURN
      END
```

Appendix D

Sample of Program Print Out

RADAR ALTIMETER DATA

ANALYSIS PROGRAM (RADAP)

VERSION-2

RADAR ALTIMETER DATA ANALYSIS PROGRAM

```
INPUT CARD DATA

BRDC =      .36210000000000E-01 ( /KM) - INVERSE CORRELATION DISTANCE
SDD =       .60000000000000E+00(METERS) - SINGLE PULSE RADAR SIGMA
NFS =     1 FUNCTION OF VERTICAL
LSX =     1 FILTER FIT / DATA SPACING
 IC =     1(0= NO FILE , 1= OUTPUT FILE)


SDV =       .20000000000000E+02 (ARCSEC) - SIGMA DEFLECTION
FDS =       .80000000000000E-01 (KMETERS) - DATA SPACING
 LFSP =        505 1/2 (NUMBER OF FILTER FIT POINTS)

TAPE INPUT


    2  82113 NOV 72 TYPE- ESCARPMENT        2   .60000000000000E+00 3751


TAPE 2 OUTPUT HEADER RECORDS


    2  82113 NOV 72 TYPE- ESCARPMENT        2   .60000000000000E+00 3751


    2     .36210000000000E-01     .60000000000000E+00    1     .20000000000000E+02     .80000000000000E-01 1011 2741


GEOID HEIGHT WEIGHT

   061260        .117362419239E-03       .127063153910E-03       .136911996051E-03       .146908030685E-03
   061264        .157050265186E-03       .167337628101E-03       .177768967965E-03       .188343052136E-03
   061270        .199058565632E-03       .209914109983E-03       .220908202085E-03       .232039273076E-03
     .                 .                       .                       .                       .
     .                 .                       .                       .                       .
     .                 .                       .                       .                       .
   063230        .220908202085E-03       .209914109983E-03       .199058565632E-03       .188343052136E-03
   063234        .177768967965E-03       .167337628101E-03       .157050265186E-03       .146908030685E-03
   063240        .136911996051E-03       .127063153910E-03       .117362419239E-03

FILM IDENTIFICATION = NW58RADAD11811 15 72
DA = HI-D BLAKE ESCARPMENT  401CA  TN =      GAUSSIAN  SIGMA= 0.6 M   IP =     6
```

GEOID HEIGHT ESTIMATES

075514	.462520104199E+01	.462449391414E+01	.462380992617E+01	.462311365414E+01
075520	.462242135689E+01	.462174271344E+01	.462107246431E+01	.462040180948E+01
075524	.461974143181E+01	.461906274472E+01	.461839250754E+01	.461772638443E+01
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
102770	-.466075486789E+01	-.466159803025E+01	-.466242982099E+01	-.466326485969E+01
102774	-.466408292532E+01	-.466490396671E+01	-.466570767759E+01	-.466651059169E+01
103000	-.466731679383E+01			

MAXIMUM GEOID HEIGHT RESIDUAL = .10 METERS

AVERAGE GEOID HEIGHT RESIDUAL = .00 METERS

SIGMA OF GEOID HEIGHT ESTIMATE = .04 METERS

VERTICAL DEFLECTION WEIGHTS

061260	.120329938956E-03	.122186681144E-03	.124032466434E-03	.125866331687E-03
061264	.127687298906E-03	.129494375325E-03	.131286553508E-03	.133062811453E-03
061270	.134822112709E-03	.136563406496E-03	.138285627838E-03	.139987697700E-03
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
063230	-.138285627838E-03	-.136563406496E-03	-.134822112709E-03	-.133062811453E-03
063234	-.131286553508E-03	-.129494375325E-03	-.127687298906E-03	-.125866331687E-03
063240	-.124032466434E-03	-.122186681144E-03	-.120329938956E-03	
111763	1371			

VERTICAL DEFLECTION ESTIMATES

075514	.179188792122E+01	.178383173742E+01	.177498956686E+01	.176932649974E+01
075520	.176095586423E+01	.175233829343E+01	.174234469100E+01	.173291455593E+01
075524	.172497897649E+01	.171946224211E+01	.171102663751E+01	.170463310075E+01
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.

102770	.214955401843E+01	.213792574374E+01	.212515260262E+01	.211283752248E+01
102774	.209988949414E+01	.208147184650E+01	.206794020877E+01	.205017994137E+01
103000	.203401168798E+01			

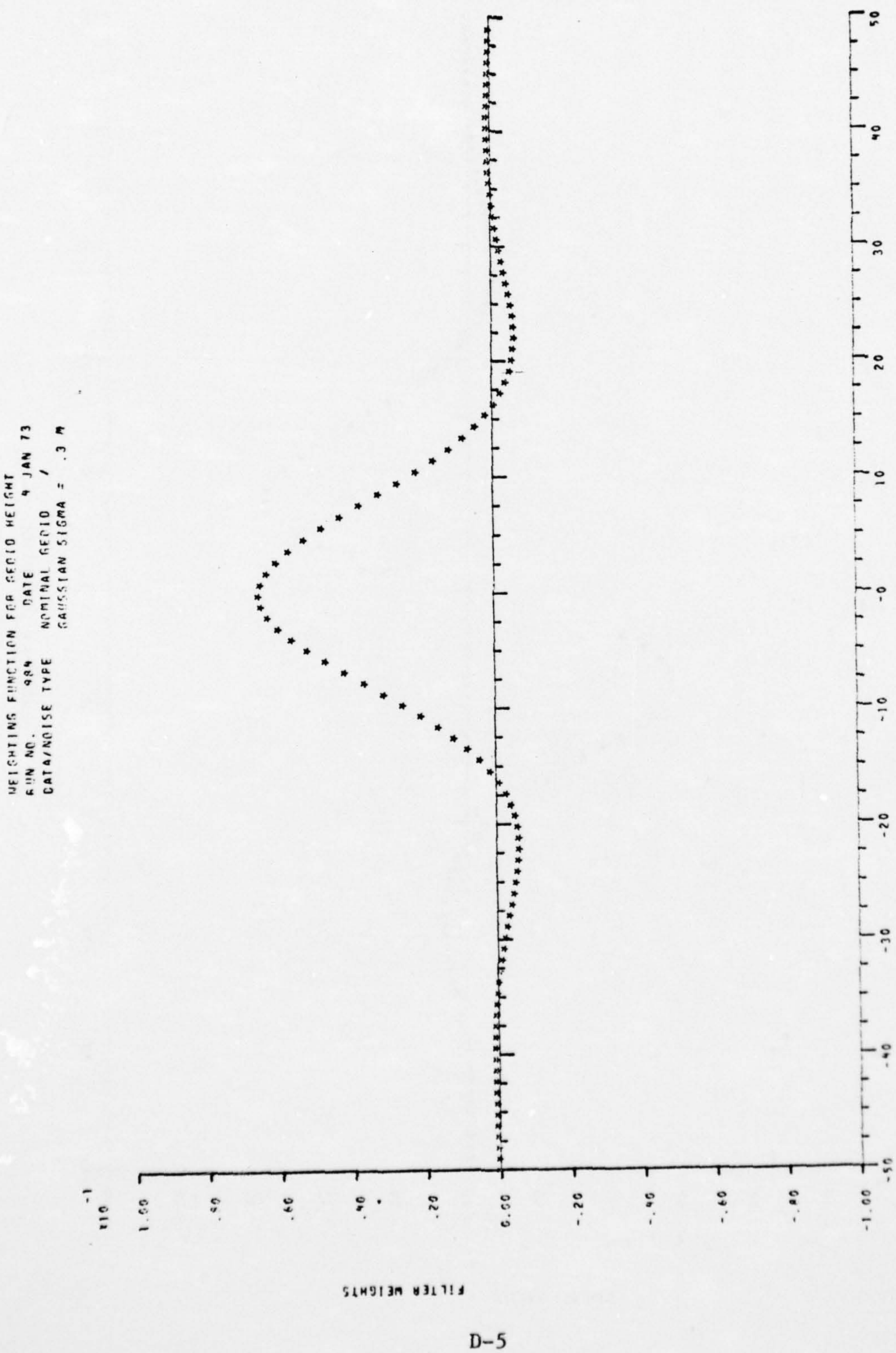
MAXIMUM VERTICAL DEFLECTION RESIDUAL = 3.72 ARCSEC

AVERAGE VERTICAL DEFLECTION RESIDUAL = -.02 ARCSEC

SIGMA OF VERTICAL DEFLECTION ESTIMATE = 1.43 ARCSEC

IT HAS BEEN A PLEASURE SERVING YOU. I HOPE YOU ENJOY YOUR 8. FRAMES OF S-C 4060 OUTPUT.

0. ERRORS DETECTED.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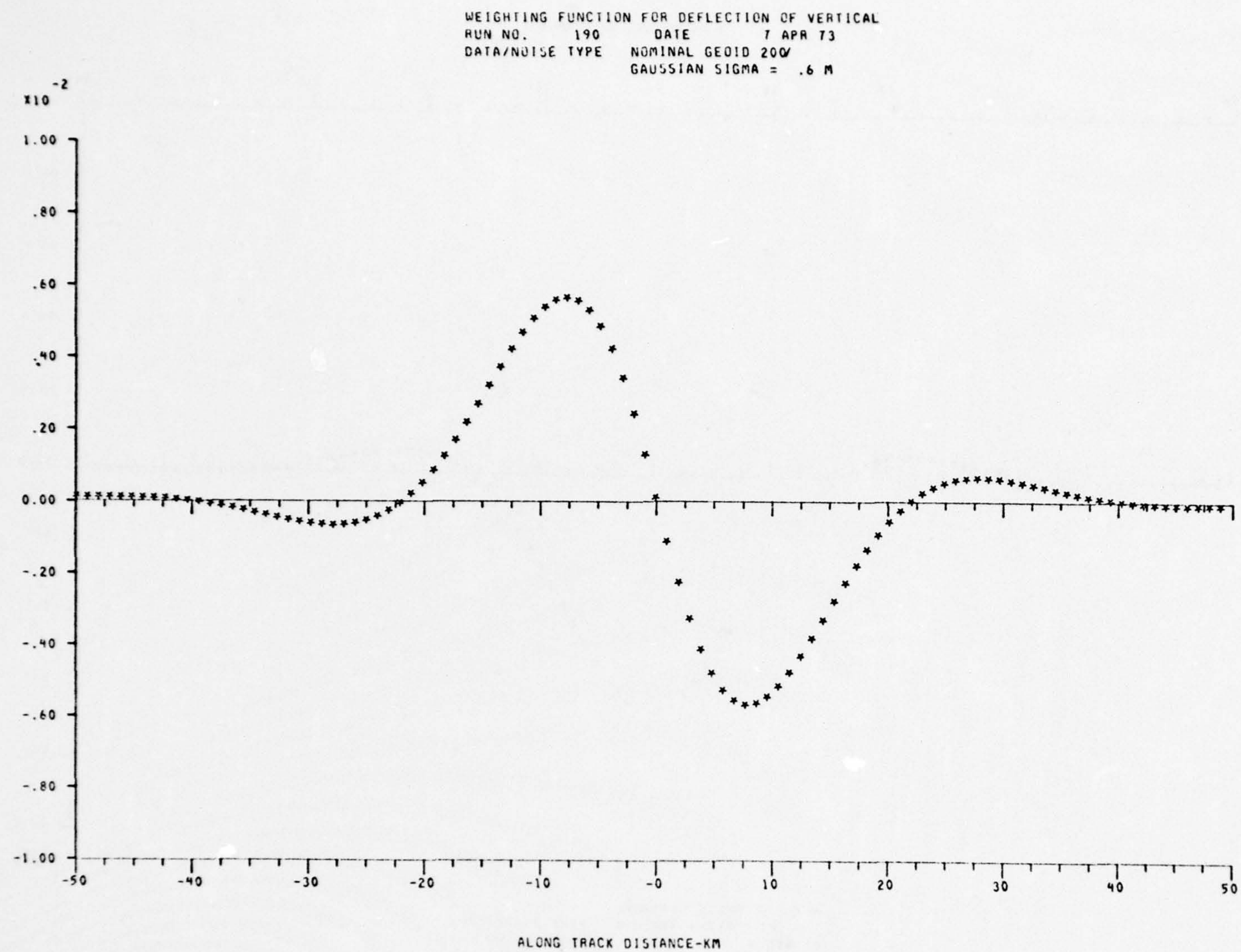
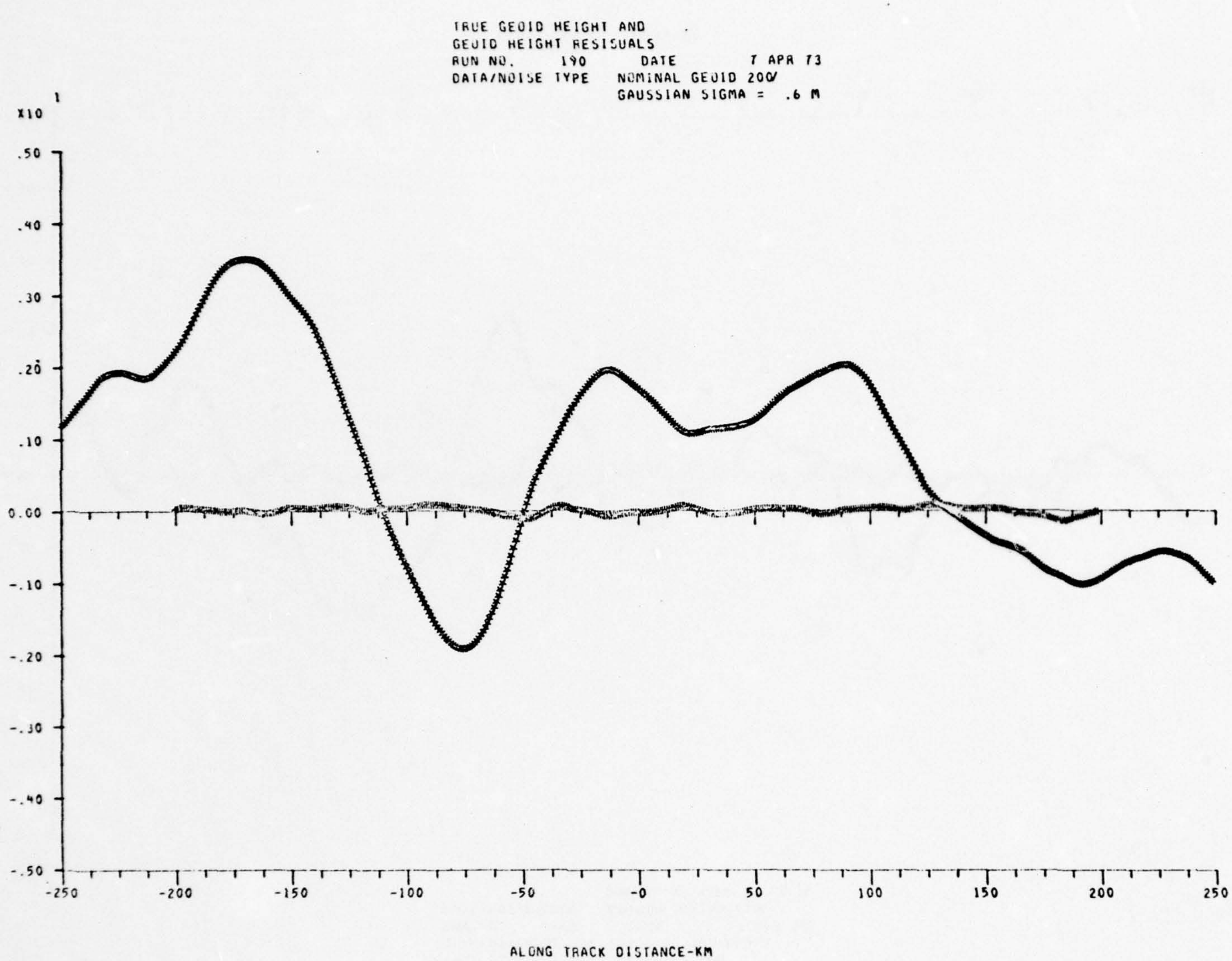
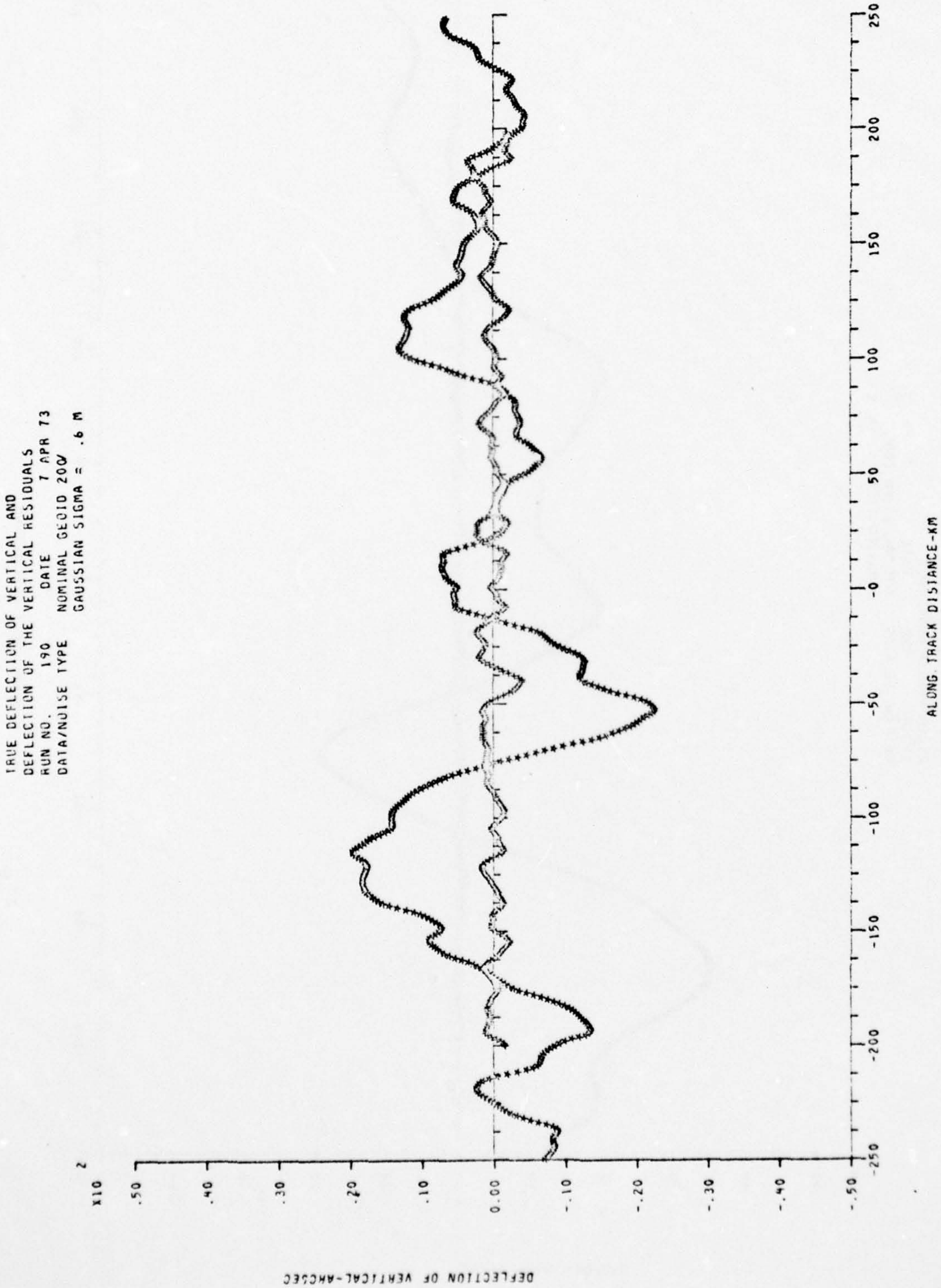
RUN NO. 984 DATE 4 JAN 73
DATA/NOISE TYPE NOMINAL GEOID /
GAUSSIAN SIGMA = .3 M
ALONG TRACK DISTANCE-KM
FILTER WEIGHTS
X10^-1
1.00
.80
.60
.40
.20
0.00
-.20
-.40
-.60
-.80
-1.00
-50
-40
-30
-20
-10
-0
10
20
30
40
50


WEIGHTING FUNCTION FOR DEFLECTION OF VERTICAL
RUN NO. 190 DATE 7 APR 73
DATA/NOISE TYPE NOMINAL GEOID 200
GAUSSIAN SIGMA = .6 M
X10 -2
1.00
.80
.60
.40
.20
0.00
-.20
-.40
-.60
-.80
-1.00
FILTER WEIGHTS
-50
-40
-30
-20
-10
-0
10
20
30
40
50
ALONG TRACK DISTANCE-KM


TRUE GEOID HEIGHT AND
GEOID HEIGHT RESISUALS
RUN NO. 190 DATE 7 APR 73
DATA/NOISE TYPE NOMINAL GEOID 200/
GAUSSIAN SIGMA = .6 M
X10 1
.50
.40
.30
.20
.10
0.00
-.10
-.20
-.30
-.40
-.50
-250
-200
-150
-100
-50
-0
50
100
150
200
250
GEOID HEIGHT-METERS
ALONG TRACK DISTANCE-KM


TRUE DEFLECTION OF VERTICAL AND
DEFLECTION OF THE VERTICAL RESIDUALS
RUN NO. 190 DATE 7 APR 73
DATA/NOISE TYPE NOMINAL GEOID 200/
GAUSSIAN SIGMA = .6 M
ALONG TRACK DISTANCE-KM
DEFLECTION OF VERTICAL-ARCSEC
X10 2
.50
.40
.30
.20
.10
0.00
-.10
-.20
-.30
-.40
-.50
-250
-200
-150
-100
-50
-0
50
100
150
200
250

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